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FOREIGN MACHINERY MERCHANTS PAGES, 408-409 ADVERTISERS INDEX, 439-440 PRODUCT INDEX, 410-436

The Editor's Monthly Talk

IN July, 1919, MACHINERY began the publication of the most complete treatise on interchangeable manufacturing that has hitherto been published. These articles, covering completely the principles of this work, appeared in eighteen consecutive numbers, the last article being published December, 1920. Owing to the wide scope of the subject, the applications of the principles were dealt with but briefly, and no attempt was made to describe actual manufacturing practice in detail. This has been done now in two articles that will be published in the February and March numbers of MACHINERY entitled "Application of Interchangeability to Drill Chuck Manufacture." These articles describe the tooling and gaging equipment used by the Marvin & Casler Co. in the manufacture of the Casler twin-screw drill chuck, and show the practical application of many of the principles that have been formulated in the series of articles previously published. They also show that interchangeability is not practicable except by the exercise of the greatest care in the planning of every manufacturing operation. All important tolerances are given, and the jigs, fixtures, and gaging methods employed are illustrated and described so that the reader can follow the complete manufacturing procedure in detail.

While this article deals with the manufacture of drill chucks, it shows also the practical application of the principles of interchangeable manufacturing to a variety of products of similar character, with similar requirements for accuracy and interchangeability. It is one of those articles that will be *studied* rather than *read* by mechanical men to whom production of interchangeable work is a vital subject.

Increasing the Efficiency of Labor

Many manufacturers have complained during recent years about the decreasing efficiency of labor. That there has been a decrease in general efficiency is beyond doubt; but some leading shop executives are of the opinion that the shop men are not alone responsible for this condition. These executives believe that by the right kind of methods in shop management former efficiency could have been maintained, and have proved it by the results they have obtained in their own shops. In an article in February MACHINERY that will be read with interest by all employers, John C. Spence of the Norton Co. explains how production may be increased by a rational piece-work system, and in another article, also published in this number, A. H. Dittmer, president of the Dittmer Gear & Mfg. Corporation, explains in detail a method worked out by his company for encouraging industrial cooperation and for obtaining the highest efficiency of which each man is capable.

The tool designer will find several articles in February MACHINERY that will be of particular interest to him. Among these may be mentioned especially "Dimensions of Straight Forming Tools," "Dies for Flanged Shells" and "Dies for Ford Automobile Hub Plates."

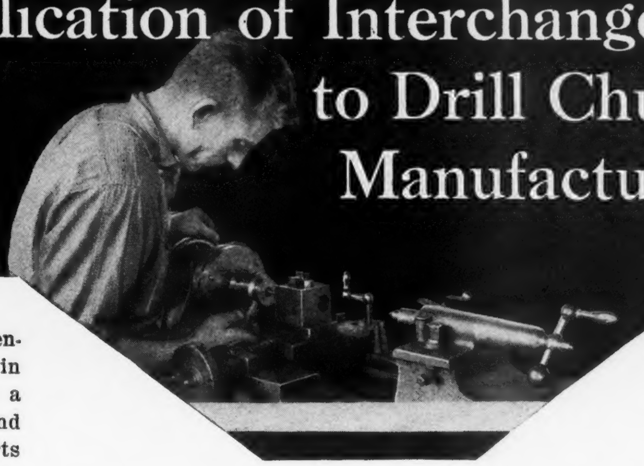
March MACHINERY will contain an unusual number of articles of special value to jig, fixture and die designers. One of these articles deals with the making of jigs and fixtures on a manufacturing basis, showing how these tools can be so designed that many of the parts used in their construction can be made interchangeable, thereby decreasing the cost and simplifying the design in a marked degree. Manufacturers will also find this article of value and interest because it points the way to a decrease in manufacturing costs and shows how one firm, by specializing in the manufacture of jigs and fixtures, can supply other manufacturers with these tools cheaper than they could make them themselves, on the same principle that manufacturers specializing in machine tools can supply better machines and at less cost than they can be made singly.

The Training of Salesmen

In the past, the salesman of machinery and engineering products was often severely criticised because of his lack of first-hand knowledge of the products he was handling. During recent years a decided effort has been made by many large manufacturers to train salesmen to become thoroughly familiar with the product they are selling. Some of the large electrical firms, as well as machine builders in other fields, have selected technical graduates from the engineering schools and put them through a kind of apprenticeship at their plants, meanwhile noting their qualifications, and if they seemed to be the right type for salesmen, their training was continued along commercial lines. One of the largest concerns in the machine tool field has made a practice of training its salesmen by putting them through a systematic course covering nearly a year. The details of this plan will be given in an article in March MACHINERY on "Machine Shop Training for Salesmen."

The articles referred to are but a few of the large number dealing with design, shop practice, foreign and domestic industrial conditions, and problems in management that will appear in March MACHINERY. All the articles, whether prepared by MACHINERY's editorial staff or by mechanical men contributing to its columns, are based upon definite practice in successful manufacturing plants. Mere discourses and theories are always eliminated. MACHINERY deals in facts—describes not proposed methods, but accomplishments—and herein lies its greatest value to its readers.

Application of Interchangeability to Drill Chuck Manufacture



First of Two Articles Describing the Tooling and Gaging Equipment Used by the Marvin and Casler Co., Canastota, N. Y., in Manufacturing the Casler Twin-screw Drill Chuck

By FRED R. DANIELS

MACHINE parts that engage each other in operation, such as a screw and nut, a dovetail and its slide, or any mating parts of special or irregular section, cannot be interchangeably produced except by the exercise of the greatest care in every manufacturing operation. When manufacturing on an interchangeable basis, conditions are encountered that require methods entirely different from those used when interchangeability is not a factor. The present article is intended to give a comprehensive idea of the methods followed in securing interchangeability in the manufacture of a device in common use in machine shops, and presents a complete description of the machining, gaging, and assembling methods followed by the Marvin & Casler Co., Canastota, N. Y., in the manufacture of the Casler twin-screw drill chuck. Each unit of the chuck will be considered separately up to the time of assembly, and all important tolerances will be given so that the procedure can be followed in detail. A variety of jigs, fixtures, and gaging methods are employed which are both novel and effective, and by the use of which all parts of one chuck will interchange with similar parts of any other having the same drill shank capacity.

Construction of the Chuck

A brief description of the construction of the chuck and its method of operation will make the reasons for following certain manufacturing methods more readily understood. The chuck consists of a cast-iron body with slots for two steel jaws, which operate radially. On the inner surface of each jaw a V-groove is machined, by means of which the drill shank is held. The jaws are manipulated by two steel screws located on opposite sides of the slot in which the jaws are fitted. One of these screws is termed the primary screw, and contains right-hand threads on one end and left-hand threads on the other; this screw engages the jaws and draws them together or opens them, according to the direction in which the screw is turned. The secondary screw is located on the opposite side of the jaws; its function is to equalize the amount of strain produced by the primary screw on the jaw teeth. Only one end of the secondary screw is threaded; the other, which is plain, fits in a circular groove in the right jaw, and the head of the screw bears against the shoulder produced by this groove to assist in tightening the chuck. By this construction, the sidewise strain which would ordinarily be produced on the jaws by the primary screw is distributed, so that a greater holding power and a better operating condition is obtained.

The secondary screw constitutes a lock for the chuck, and must be turned before it is possible to open the chuck by means of the primary screw. The shape of the jaws is such as to fit the vertical gash and the T-slot in the body, this gash and slot being clearly shown in Figs. 3 and 4. The jaws will be dealt with in the second installment of this article. In the upper right-hand corner of Fig. 1 is shown a cap-plate which is screwed to the large end of the chuck as a means of preventing it from spreading under strain.

This brief description of the construction of the chuck, in conjunction with the illustration Fig. 1, should be all that is necessary to enable the machining and gaging operations to be followed. For the purpose of describing the manufacture of this type of chuck, the intermediate size—having a drill shank capacity up to 3/4 inch—has been selected, and all tolerances given are applicable to this size of chuck.

Preliminary Operations in Making the Chuck Body

The body of the chuck is made of close-grained cast iron. It is machined from the solid, there being no cored sections in the casting. The castings are first centered at both ends on a Whiton centering machine. The small end of the body is then recentered to obtain a uniform distance between centers regardless of variations in the rough over-all length of the body. This recentering operation is performed on an upright drilling machine, the table of which contains a plug center so that the work may be located on it in a vertical position while the small end is being recentered with a combination center-drill.

A Porter-Cable lathe is next employed for rough- and finish-turning the two diameters of the body and for rough- and finish-facing the ends. The turning tools are carried on the front cross-slide of the lathe, and the facing tools, on the cam-operated back-slide. This cam is a two-throw cam having a 1 1/8-inch rise. The work is held between centers and is driven by a special lathe dog and a driver attached to the faceplate. After the small end of the body has been rough-turned and rough-faced, it is necessary to reverse the work to perform similar operations on the large diameter of the body. In performing the finish-facing and finish-turning operations the same procedure is repeated. The diameter is finished to within limits of $\pm$ 0.005 inch, which furnishes sufficient leeway for truing up and grinding for finish, the latter operations being performed after the chuck is fully assembled. A complete set of profiling and snap gages is employed to hold the work within the established limits.

After the work has been faced, a projection is left on each end surrounding the center, which could not be removed during the facing operation. This projection is next removed with a 3/4-inch drill. The next operation consists of finish-grinding the small end to length, the work being done on a Blanchard grinder and held to limits of ± 0.002 inch, by the use of suitable length gages of the regular type.

The four cap-plate screw holes are next drilled in the large end of the body on a Henry & Wright drilling machine, after which the work is located in a special drill jig by means of two pins which fit two of these cap-plate holes. This jig in which all the remaining drilling operations are performed is first used to drill the shank hole in the chuck body. After the shank hole is drilled, the jig is placed on its side and two 7/16-inch holes are drilled through the body. This operation is performed by running the drill half way through the casting and then reversing the jig and drilling in from the opposite side as a precautionary measure for preventing the hole from running out. These two holes are indicated at *A*, Fig. 1, and from them the operating screw recesses are subsequently machined. The two recesses, however, are not of the same diameter throughout; the one in which the primary screw is assembled has a shoulder to fit the neck of the screw, as indicated at *U*, while the other recess is a straight gash.

By removing the drill bushing from the drill jig used in the preceding operations, both these holes are next counterbored to 25/32 inch in diameter, which produces the shoulder previously mentioned by means of which the primary screw is located in the chuck. The stop on the drilling machine spindle is set so that a liberal amount of excess stock is left on this shouldered section of the recess, which is subsequently finished to length. This procedure is also followed in counterboring the secondary recess simply because it is convenient to do so with the work located in the jig. Another operation is then required to clean out the shoulder section left in the secondary screw recess.

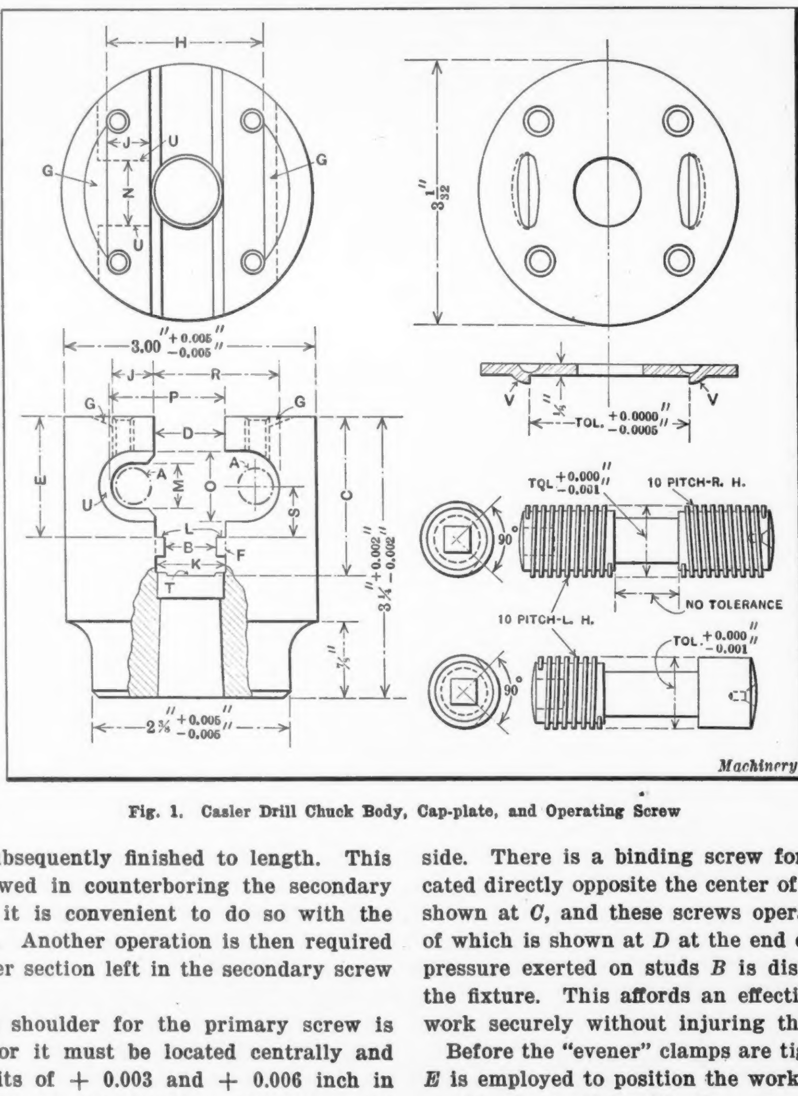


Fig. 1. Casler Drill Chuck Body, Cap-plate, and Operating Screw

The finishing of the shoulder for the primary screw is of great importance, for it must be located centrally and finished to within limits of + 0.003 and + 0.006 inch in length. The basic length of this shoulder and of the neck of the screw (on which no tolerance is allowed) is the same, so that the limit set for the shoulder is apparently in the wrong direction, that is, it is larger rather than smaller than the basic dimension. But this is done designedly so that during the assembling operation the screw may be forced into place and turned until the faces of this shoulder become burnished. It is claimed that the surface produced by thus operating a hardened steel member against a cast-iron surface has high wearing qualities comparable to a chilled or casehardened surface. A set of special gages is used to check the location of this shoulder and to hold it within the required limits.

Fixture Used in Milling the Jaw Gash

Up to this stage in the description of manufacture there is no particular difference between ordinary manufacturing methods and interchangeable manufacturing procedure. From this point on the machining operations performed on the body of the chuck determine to a large extent the degree of interchangeability obtained, and for that reason particular attention will be called to the gaging methods which have been devised for locating the various body surfaces in contact with which the screws and jaws operate. The location of the jaw gash and operating screw recesses is important from the standpoint of the running conditions of the chuck, whereas the tolerances on these machined surfaces are the main consideration for establishing interchangeable manufacturing conditions.

The operations already performed on the screw holes, that is, drilling and counterboring, do not in any way affect the accuracy with which the screw recesses are finally finished, and so cannot be considered from an interchangeable manufacturing basis, being merely a preliminary series of operations. The milling of the gash in the body in which the jaws function is performed on a Briggs miller, equipped with a special string milling fixture, as shown in Fig. 2. The method of clamping the work in the fixture can be clearly seen in the illustration, and a number of gages employed in connection with this operation are also shown in this view.

There are a number of pack-hardened studs *A* driven into the cast-iron body of the fixture, and when the work has been put in place a pair of small pack-hardened steel plugs, such as shown at *B* and also on the table of the machine, are dropped in between adjacent pieces of work, one on each side. There is a binding screw for each piece of work, located directly opposite the center of these two small plugs as shown at *C*, and these screws operate "evener" clamps, one of which is shown at *D* at the end of the fixture, so that the pressure exerted on studs *B* is distributed to both sides of the fixture. This affords an effective means of holding the work securely without injuring the exterior surface.

Before the "evener" clamps are tightened, an aligning gage *E* is employed to position the work so that the gash will be machined parallel with the screw recesses. These screw recesses, it will be recalled, were drilled and counterbored in a fixture which made use of the cap-screw holes in the end of the chuck body to locate the work; these same cap-screw holes are now utilized in locating the work during the milling of the jaw gashes. The aligning gage consists merely of two pairs of accurately spaced steel pins, one pair of which *L* is mounted in an adjustable member of the gage, so that in case the diameters of the chuck bodies vary, suitable adjustment may be made to agree with the resulting spacing of the pairs of holes on each side of adjacent bodies. As soon as one pair of bodies has been aligned and clamped the gage is removed and the holes in the second body become

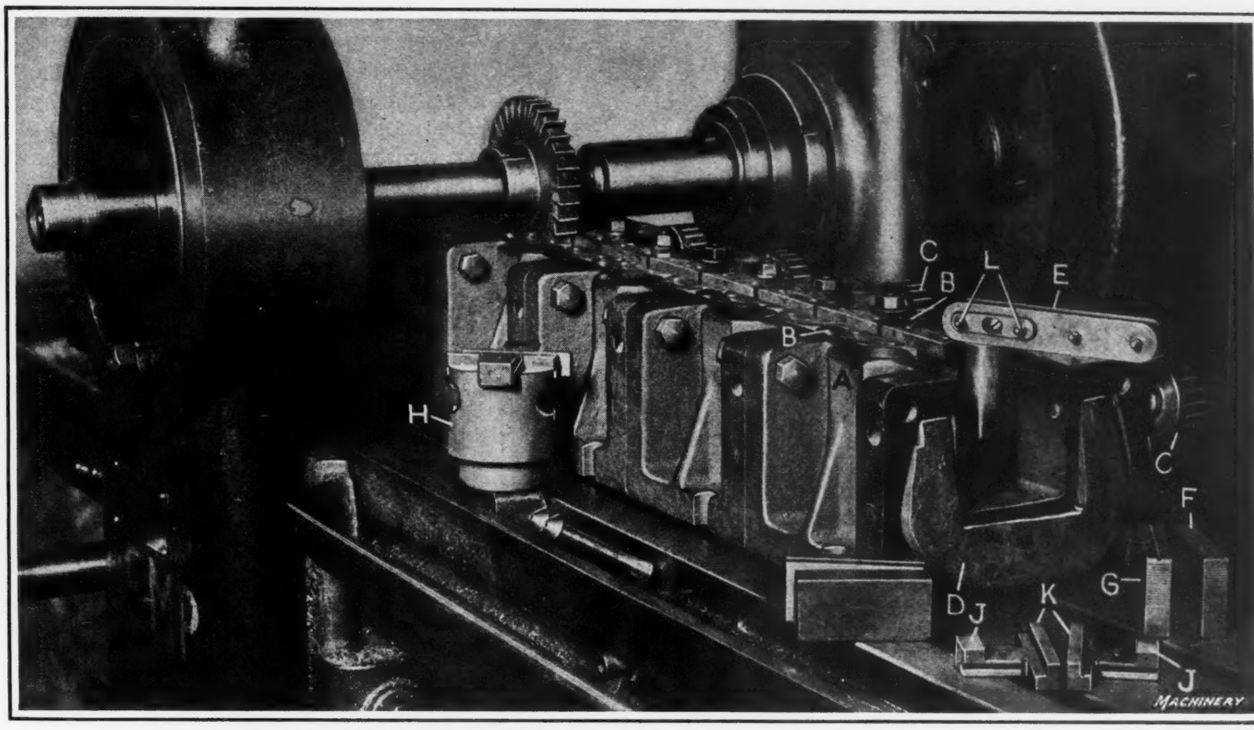


Fig. 2. String Milling Fixture in which the Bodies are held while the Jaw Gashes are being milled

the locating centers for aligning the next body, and so on until the entire string is aligned.

Milling and Gaging the Slot

There are two cuts taken in milling the jaw gash, the first of which mills the gash to the width *B*, Fig. 1, and to the depth *C*. For this operation a single inserted-tooth cutter is used in connection with a special arbor. The fixture has a tongue which fits in a T-slot of the table, so that by using a special arbor, only slight adjustments are required for establishing a central location for the cutter. In taking the second or finishing cut, the same fixture is employed, but the arbor carrying the single cutter is replaced by one having two side milling cutters for milling the slot to width *D* and to depth *E*. The illustration Fig. 2 shows the separate arbor with its two side milling cutters, used in taking the second or finishing cut. The limits for width *B*, Fig. 1, are ± 0.005 inch, but for width *D* the total tolerance is only — 0.002 inch, which it will be noticed is an extremely close fitting allowance. For that reason the practice of employing two side milling cutters spaced by washers of suitable thicknesses, rather than a single cutter enables the reduction in width, due to wear and grinding, of the cutting edges to be compensated for by simply changing the spacing washer. Depth *E* has a tolerance of 0.008 inch, and produces the vital registry surfaces *L* from which the work is located during subsequent milling operations and against which important operative surfaces of the jaws function. The limit on dimension *C* is ± 0.005 inch and as this surface does not come in contact with the jaws, a tolerance of this liberality is permissible.

Several gages are shown on the milling machine table in Fig. 2; *F* is a "Not Go" gage for width *B*, Fig. 1, and *G* a combination "Go" width and limit height gage for this same gash. A similar pair of gages is employed to inspect the depth and width of the second or finish cut, these being shown near the front corner of the fixture. In addition to these gages for width and depth of the gashes, a unique gaging method is used to inspect the central location of the gashes. The gages used for each cut are of the same design, and it has been endeavored to illustrate their use by showing one pair of these gages located on the work *H* as in actual gaging, and another pair lying face upward on the table so that the principle employed to check this location may be clearly understood.

The two gages are shaped to resemble somewhat the letter T, and there is a lug on the vertical and on the horizontal parts of each gage. Lugs *J* have an inner angular surface while lugs *K* are parallel, and their total width is such that when matched together they will slide into the particular gash in which they are used. The upper surfaces of these gages are graduated so that when the pair is slid into the gash, with the gages resting on the top of the body as shown at *H*, the angular surfaces of lugs *J* will be tangent with the circumference of the body, and if the gash is properly located the graduated lines on the two gage members will align. The graduations are so placed on the gages that the location can be readily determined within very close limits. The importance of holding this central location to within a tolerance as small as 0.005 inch will be fully realized as the progress of the subsequent milling operations is followed.

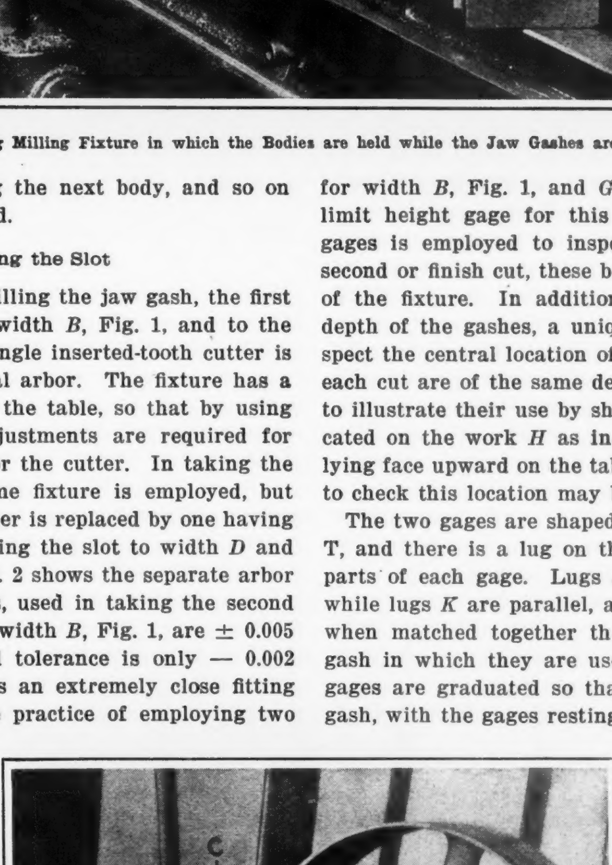


Fig. 3. Cradle Fixture in which the Work is located during the T-slotting Operation

During the milling of this jaw gash, the four cap-plate holes are tapped in a drilling machine located conveniently in relation to the Briggs miller. The next operation is of minor interest and consists of reaming a clearance hole

Fig. 4. Gaging the Central Location of the T-slot with Relation to the Jaw Gash

for the shank of the maximum size drill for which the chuck is intended. This clearance cut is indicated in Fig. 1 by dotted lines *F*. In describing the construction of the chuck, it was stated that a cap-plate is attached to the end of the chuck body to prevent it from spreading when in use, and the next operation on the body, which is performed on a Whitney hand miller, consists of straddle-milling the gashes *G*, Fig. 1, in which the cap-plate tongues fit when the plate is assembled. These gashes must be accurately machined and spaced to gage dimensions. The work is located in a vertical position in a fixture which carries a tongue that fits into the previously machined jaw gash. A limit snap gage is used to maintain the proper width between cuts to within a tolerance of 0.0005 inch, the limits being from plus 0.001 to plus 0.0015 inch for distance *H*. The cap-plate is a "snap" fit in these gashes, and the corresponding dimension on the cap-plate has an even closer limit, as may be seen by referring to the sectional view of the cap-plate shown in the upper right-hand corner of Fig. 1. The central location of these cuts in the body is checked by gaging dimension *J*, from the side of the jaw gash to the vertical side of the cut, a limit snap gage being employed to hold this dimension within limits of ± 0.0035 inch. A combination contour and depth gage checks the depth of these gashes.

Fixture and Gaging Methods Used in T-slotting the Body

The T-slotting operation by means of which slot *K* is milled is performed on a No. 1½ Garvin duplex miller provided with a fixture as illustrated in Fig. 3. This fixture is in the form of a cradle with clearance slots *A* for the T-cutter and steel plates with locating fingers *B* which are the proper distance apart to accurately fit width *D*, Fig. 1, so that the body may be slid into the cradle, guided by these fingers until the inner vertical surface of each finger abuts against the bottom of the jaw gash, that is, against surfaces *L*. With the work thus located in the fixture, the relation of the T-slot to the jaw gash and seat *L* may be definitely established. A leaf *C*, Fig. 3, with a floating plug *D* that enters the shank hole of the chuck clamps the chuck body in such a way that the two locating surfaces previously mentioned snugly engage the steel fingers *B*.

The width, height, and central location of this T-slot must each be held within very close limits, and a number of interesting gages are employed to check this T-slot. These are shown in Fig. 4. The thickness and width gages are of the same type and are shown strung together lying on the bench. There is a "Go" and a "Not Go" gage for width and a "Not Go" gage for height of the slot. The checking of the central location of the T-slot is an interesting process, and in the illustration the inspector is engaged in checking this central location. A steel gage-block *A* fits the jaw gash and seats on surface *L*, Fig. 1. The gage has a tapered tongue which extends down to the bottom of the T-slot. The angle of this tapered tongue is located symmetrically with relation to the center line of the gash and two flat graduated steel pieces such as shown at *B* are used in connection with the tapered tongue on block *A*. One side of each of these steel pieces is machined at the same angle as the surfaces of the tongue so that the flat steel pieces may ride on the angular surfaces of the tongue; and if the slot is centrally located, corresponding graduation marks on each steel piece will coincide when they have been slid in as far as possible. The graduations are so calibrated that the amount of error can be read to thousandths of an inch.

The width of the T-slot has a tolerance of + 0.015 inch, and the height a tolerance of + 0.001 inch. The shallow groove formed at the bottom of the T-slot in this operation receives a slight tongue on the jaws. However, surface *T*, Fig. 1, is not a functional surface since there is a slight clearance between it and the jaw. The distance from surface *T* to the bottom of the T-slot is 0.015 inch, which leaves a clearance for the jaws of about 0.01 inch. At this stage of the machining operations composite functional surfaces have been produced, so that a functional gage must be employed to check the entire T-slot and its relation to the jaw gash. This functional gage is shown at *C*, Fig. 4, one side of which is a "Go" gage and the other side a "Not Go" gage. Another gage of somewhat similar type to the functional gage is shown at *D*, but the slots in the side are not gaging surfaces —they are merely clearance cuts so that the height from the bottom of the T-slot to the top of the body (that is, distance *C*, Fig. 1, minus 0.015 inch) may be gaged to within limits of ± 0.005 inch.

Fixture Employed for Milling the Screw Recesses

The next series of milling operations includes the operations by means of which the previously drilled 7/16-inch holes and the 25/32-inch counterbored holes for the operating screws are milled open. These are the final machining operations performed on the chuck body, the work being done on a No. 1 Garvin duplex miller shown in Fig. 5. A rather in-

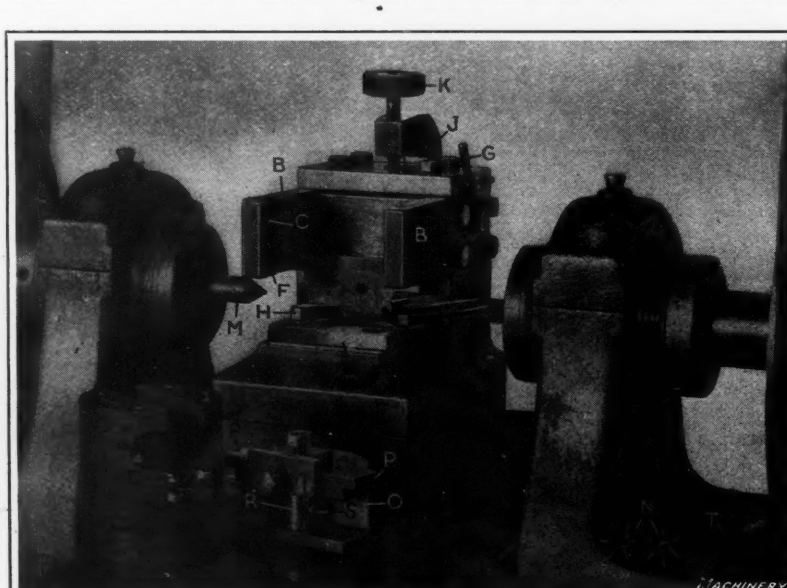


Fig. 5. Fixture in which the Chuck Bodies are held for finishing the Operating Screw Recesses

teresting fixture has been devised for holding the work during the several milling operations performed on this machine. The fixture has a steel block with a locating tongue *A* which is an accurate fit in the jaw slot so that the work may be inverted and seated on this block. Two arms *B* on the upper part of the fixture extend to the front over the center line of the machine spindles, and these arms contain vertical grooves *C* which in conjunction with the horizontal seat or block are employed to maintain an exact perpendicular position for the work.

An accurately machined slide *D* is pushed into the T-slot of the work and protrudes from the body about as shown in the illustration. This auxiliary slide has a semicircular groove *E* at each end so that when the work is inverted and seated in the fixture, these grooves will engage ears *F*, located at the lower end of grooves *C*, and will insure parallelism of the T-slot with the center line of the machine spindle. It is evident that slide *D* is of such a length and width as to fit nicely in the vertical grooves of arms *B*. There are two sliding square fingers resembling keys which operate in the arms of the fixture by means of a pin-lever *G* so that they may be advanced to slide over the top of the extending ends of the auxiliary slide and thus prevent the work from rising from its seat. With the work thus located, cradle *H* is advanced against the chuck body to clamp it securely in place. This cradle is operated by a hardened detent which extends backward through the base of the fixture so that its extending end may be engaged by the lower end of lever *J* which is pivoted on the fixture. Then by operating the knurled screw *K* so that the horizontal end of this lever will be raised, the lower end will advance the cradle by means of the detent previously mentioned. This permits the cradle to center itself on the chuck body, and equalizes the pressure exerted by screw *K*.

Screw-recess Operations, Tolerances, and Gaging Methods

The first operation performed in this jig is that of milling out the stock in the primary screw recess, which was left after the 7/16-inch hole was drilled through this side of the body—that is, the finishing of dimension *M*, Fig. 1. In performing this operation, the milling cutter *L*, Fig. 5, is advanced until it is centered by the regular lathe center *M*, so that the cutter will be prevented from running out. The position of the milling machine head was changed in taking the photograph, to obtain a better view of the fixture.

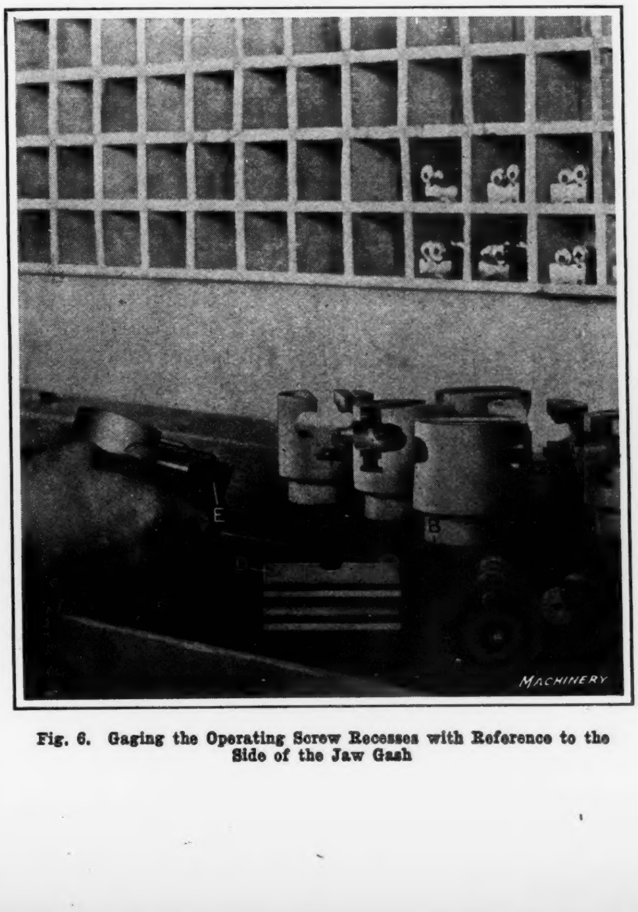


Fig. 6. Gaging the Operating Screw Recesses with Reference to the Side of the Jaw Gash

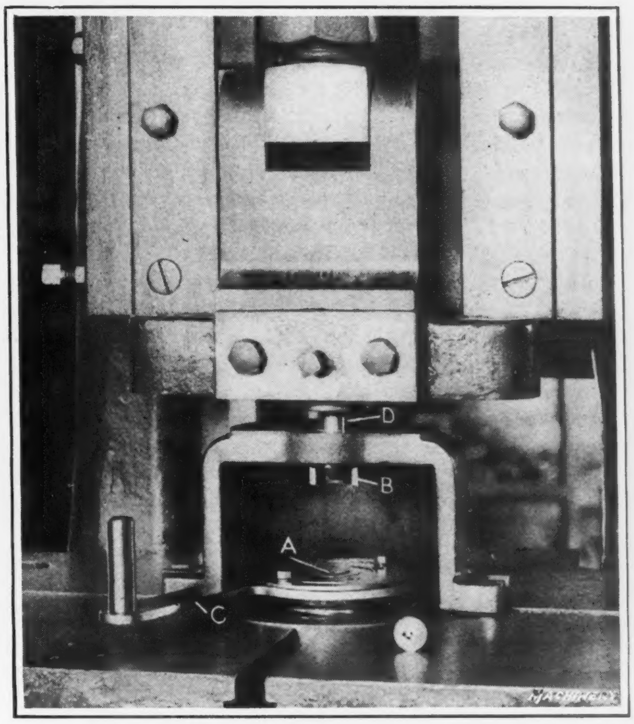


Fig. 7. Clamping Fixture in which the Operating Screws are held while broaching the Wrench Hole

With the cutter advanced and centered, the work is slid down between the arms of the fixture and over the milling cutter until the jaw gash in the chuck body encloses the tool. The diameter of the primary screw neck has a clearance in the recess milled at this time, so the tolerance on the diameter *M* of the recess (see Fig. 1) is not of so much importance as the straddle length of this recess, that is, the distance *N* between shoulders, which is finished in the next operation. The plus limit for dimension *M* is 0.005 inch and the minus limit 0.016 inch.

The recess for the body of the primary screw and the shoulders for the neck recess are rough- and finish-milled, using the two end-mills shown at *N*, Fig. 5, to replace the milling cutter and center with which the machine shown in the illustration is equipped. In setting up for the finishing operation, a special centering gage *O* is used to locate the heads of the milling machine so that the ends of the milling cutters will be located equidistant from the center of the fixture. In obtaining this location for the end-mills, the gage, which has the contour of one-half the chuck body with the slide *D* assembled, is located in the fixture in place of the chuck body. It will be noticed that the projections *P* fit the vertical slots in the fixture arms and that their top surfaces may be engaged by the sliding fingers operated by pin-lever *G* to hold the gage in position. Stud *R* carries a steel pin *S*, and in locating the spindle heads one end-mill is advanced until the end of this pin is just touched by the cutter. Stud *R* is then revolved 180 degrees and fastened, and the other end-mill is similarly advanced to come in contact with the end of the pin *S*. The gage is then removed, the distance between the ends of the cutters measured, and each head is relocated at one-half the difference between this measurement and the desired length of the primary screw neck recess. This results in centrally and accurately locating the end-mills for the finishing operation.

The length of the neck of the primary screw has no limit allowance, so that the plus limits for dimension *N*, Fig. 1 (0.003 and 0.006 inch), represent an over size. In assembling, this necessitates forcing the primary screw between the shoulders of the recess; and as the screw is a hardened steel member it acts as a burnisher, finishing the shoulders of the recess and producing a hardened wearing surface on them. These surfaces *U* are burnished by simply working the screw until the desired fit has been obtained.

In milling the seat for the body of the secondary screw, the milling cutter *T*, Fig. 5, is used, and in this operation only one cut is required, since there is no shoulder to be accurately finished to a straddle length as in the case of the primary screw. It is obvious that this condition was responsible for the use of a roughing and a finishing cut on the primary screw recess. The limits on the diameters *O*, Fig. 1, of the recesses for the two operating screws are + 0.005 and + 0.012 inch, and of the corresponding diameters of the screws + 0.000 and — 0.001 inch. Fig. 6 illustrates the type of gages employed to test the accuracy of the operating screw recesses. There is a combination "Go" and "Not Go" gage *A* for inspecting the straddle length of the shoulder; one "Go" and one "Not Go" plug gage for the diameters of the screw recesses, shown at *B* and *C*; a limit gage *D* for inspecting dimension *P*, Fig. 1; and a similar gage *E* for checking dimension *R*. The limits on dimension *P* are — 0.0055 and + 0.0045 inch and for dimension *R* + 0.0015 and + 0.0065 inch. Both of the gages used in checking dimensions *R* and *P* slide on surface *L*, so that when these dimensions come within the "Go" limits, dimension *S*, which is the distance from the center of the operating screws to the important surfaces *L*, will be within the established limits of ± 0.002 inch.

In reference to the checking of dimensions *P* and *R*, Fig. 1, the previously gaged surfaces of the jaw slot are the registry surfaces so that the operating screw recesses become symmetrically located and within a close functional tolerance. After the chuck body has reached the final stage in its manufacture, it is given a complete inspection. This is a bench job and completes the work on the body except that performed after assembly, as previously stated.

Machining the Operating Screws prior to Cutting the Threads

The primary screw with its right- and left-hand threads and the secondary screw having a left-hand thread at one end and a plain cylindrical diameter on the opposite end are illustrated in the lower right-hand corner of Fig. 1. These screws are made from Midvale special screw stock containing 0.80 to 0.90 per cent carbon. The operations performed on these two screws are substantially the same except in respect to the plain end of the secondary screw; consequently the description will be confined to the primary screw and the method of manufacturing it.

The stock is roughed out to length, one end chamfered, the other rounded, and a hole drilled in the rounded end, during the first operation which is performed on a Jones & Lamson single-spindle flat turret lathe. The blanks are next set up in the clamping fixture shown in Fig. 7, where the hole in the end that was drilled during the first operation is broached square, this being the chuck wrench socket. The work is performed on a Bliss No. 21 power press, and is seated within the clamping fixture at *A*, being supported at the other end by the hollow center *B*. When the work is properly located, the lever *C* is tightened and the work held in alignment with the square broach which operates in sleeve *D* as a guide. The blanks are then centered on the opposite ends, and the over-all length corrected to limit gage measurements, this work being done on a Pratt & Whitney screw machine.

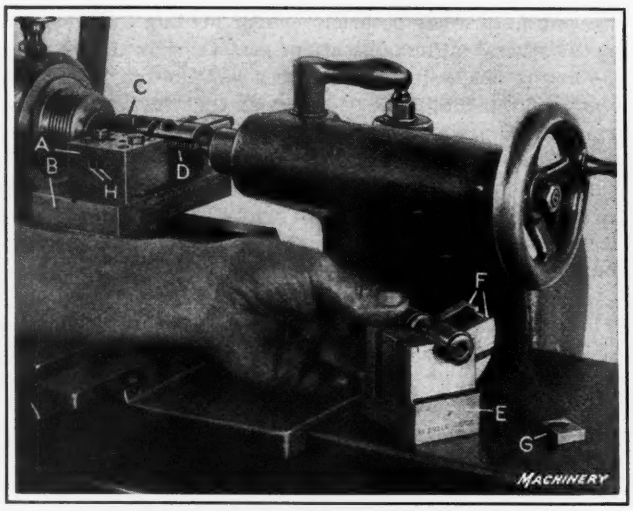


Fig. 9. Gaging Equipment used for testing the Screw and for centrally locating the Tool-block

The next operation is performed on a Pratt & Whitney hand screw machine, and consists of rough-turning the neck, after which the set-up shown in Fig. 8 is employed to finish-turn the outside diameter, form the shoulders on each end of the threaded portions, and turn the neck to nearly its finished diameter. There is a limit on the large diameter of 0.002 inch, but none on the diameter of the shoulders, which is the same as the root diameter of the screw, and none for the length of the neck. It has already been mentioned that the length of the recess in the body in which this neck fits is purposely made over size so that the wearing surfaces of the shoulders of this recess may be burnished or glazed to increase their wearing qualities. The equipment used on the Porter-Cable lathe shown in this illustration, consists of a square center as a driver, a special tool-head *A* in which the shouldering tools and the forming tool for the neck are carried, and two turning tools and tool-holders (one of which is clearly shown at *C*). The turning operation is performed simultaneously with, and independently of, the operations performed by the tools carried in the tool-head. In setting up the machine, a Koch indicator is used as shown in the illustration, to enable a more accurate setting of the tool-head to be made. It will be seen that the neck-forming tool may be adjusted in its angular slot by means of screw *D*, independently of the shouldering tools. The finished diameters are checked by limit snap gages.

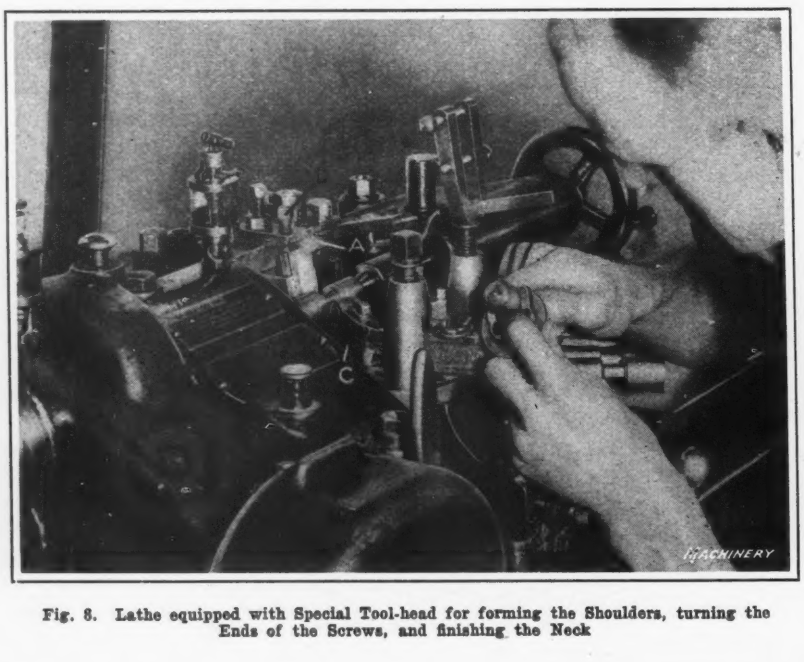


Fig. 8. Lathe equipped with Special Tool-head for forming the Shoulders, turning the Ends of the Screws, and finishing the Neck

Cutting the Threads in the Operating Screws

The screws are now ready to be threaded, and this operation is done on a thread-cutting lathe made by the Automatic Machine Co., equipped with a Pratt & Whitney square thread tool-holder. A square center is used to drive the screw blanks and a master screw employed to set the Rhodes threading tool used. There are 10-pitch square right-hand threads cut on one end and left-hand threads of the same size on the other end; the equipment for both is the same except as it may be varied to meet the opposite hand of the threads.

It is important that the threads in operation start engagement at the same time, that is, the beginning and end of the threads must bear the same relation to each other on opposite ends of the screw; otherwise simultaneous engagement and disengagement with the two jaws will not be realized. This relation is 90 degrees, as indicated on the end views of the screws, Fig. 1. The next operation, therefore, consists of straddle-milling the ends of the threads on a Whitney hand miller equipped with an arbor on which there are four cutters, so that the operation may be done at one setting by simply turning the work through 90 degrees after the two adjacent ends of opposite-hand threads are milled, to bring the opposed ends of the threads under the cutters.

Final Machining Operations on the Screws

The operation of finish-facing the neck and finish-turning its diameter is performed on a Porter-Cable lathe and is illustrated in Fig. 9. The tool-block *A* is mounted on a special plate *B*, at the rear of which a Koch indicator is attached in line with the center of the tool-block. The tool-block contains two square slots *H*, which are machined at an angle, so that the two facing tools may be adjusted to suit the length of the neck. This angular position of the tools also provides the necessary clearance. It is necessary not only that the length be precisely obtained, but also that the neck be centrally located on the screw so that corresponding points in opposite-hand threads will bear the same relationship to the center of the screw.

For obtaining this condition a gage *C*, in the form of a section of a hollow cylinder is laid on the screw *D* while it is held between centers on the machine. This gage is provided with two short pins projecting from its inner wall, which are accurately spaced from a central groove in the gage. By laying this gage on the work and turning it slightly until the pins bind in the opposite-hand threads, it is a simple matter to adjust the carriage of the lathe laterally so that the center of the tool-block will coincide with the center of the screw regardless of the location of the neck as machined in previous roughing operations. In obtaining this central location for the tool-block and tools, the point of the indicator is brought into contact with the central slot in the gage, and the carriage adjusted as required.

The effectiveness of this simple method of locating the neck with regard to corresponding points of the threads is then checked by means of special aligning gage *E*. This gage consists of a block, in the cradle of which the screw neck fits, and two tumblers *F* in each of which there is a pin which engages with the opposite-hand threads as the screw is turned. Then by continuing to turn the screw, the tumblers will be raised and the differences between the angular elevations of the top surfaces noted. This difference indicates the amount of inequality between the center of the neck and similar points on the screw thread with which the pins are in engagement. Since the tumblers are suitably graduated, the amount of error can be read in thousandths of an inch. The width between shoulders (on which there is no tolerance allowed) is checked by the plain master block *G*. This facing operation is of paramount importance in securing the desired functional qualities of the chuck and in promoting interchangeability, for even though the threads are accurately cut, any deviation from the central location of this neck will cause the screws to bind in use.

After being burred and given a final inspection, the screws are heat-treated by hardening at 1420 degrees F., and quenching in oil, and are finally drawn at 750 degrees F. in a nitrate solution for a period of thirty minutes. The screws are then wired, brushed, and ground on the outside diameter on a Brown & Sharpe cylindrical machine, using a square center as a driver, a Norton 46-J wheel, and a limit gage for holding the diameter within a minus tolerance of 0.001 inch. This provides a minimum clearance of 0.005 inch and a maximum clearance of 0.013 inch between the screw and its recess in the chuck body.

Making the Cap-plate

The cap-plate, which is attached to the top of the chuck body to prevent its spreading under strain, is shown in the upper right-hand corner of Fig. 1. This plate is made from cold-rolled steel, and is first blanked and pierced on a power press, after which the lugs *V* are produced by an embossing punch and die. These bosses are milled to within limits of + 0.000 and — 0.0005 inch, on a Whitney hand miller, and suitable limit gages are used to check this dimension. The screw holes are next countersunk, the piece burred and inspected, and its top surface disk-ground. This completes the machining operations on the cap except for finishing the diameter after assembly.

The second installment of this article will appear in the March number of MACHINERY, and will deal with the machining and gaging methods used in the manufacture of the drill chuck jaws as well as with the special equipment employed, concluding with a complete description of the assembling process.

* * *

BRITISH STANDARDS FOR MILLING CUTTERS

The British Engineering Standards Association has recently issued report No. 122, 1920, dealing with British standards for milling cutters and reamers and giving the results achieved in the standardization of the nomenclature and definitions of these tools. A large number of tables of dimensions and tolerances are included and an index is added for ease of reference. The work was undertaken in response to a direct request from the small tool and machine tool makers of the country, to fill a recognized need. A fully representative conference was convened, as is the usual custom of the association before embarking upon any new work. Committees were appointed to carry out the various sections of the work, and these met in different parts of the country in the various centers of the tool industry, thus saving much time to the members and bringing them into close touch with actual practice.

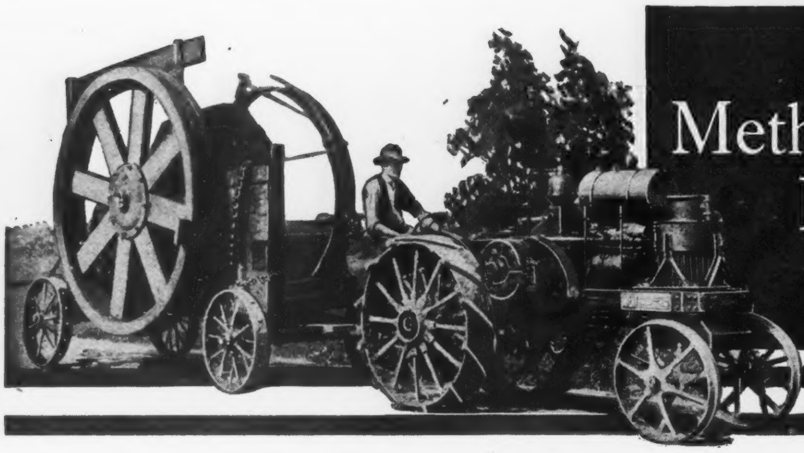
The committees were thoroughly representative, including as they did manufacturers of the tools, makers of the machines in which they were used, and representatives of the users. The tools considered were divided into four classes: Non-relieved cutters; end-mills; form relieved cutters; and reamers.

The report commences with definitions of the various classes of milling cutters and reamers, followed by a valuable series of definitions of various types of each class, each type being accompanied by a clear explanatory diagram. It contains fifty-eight tables giving the standard dimensions and tolerances of the various tools, including tables of Brown & Sharpe and Morse tapers. Standard dimensions of arbors, keys, and keyways are also given.

A report covering so wide a field of industry is sure to be susceptible of amendment, and it is hoped that experience in its use will indicate the directions in which any revision may be called for; and in order that any advance in manufacturing methods may be given effect to, an opportunity is afforded at least once a year for the revision of all specifications issued by the association. The price of the report is 1s. 3d., and copies may be obtained on application to the Secretary, British Engineering Standards Association, 28, Victoria St., S.W. 1, London, England.

* * *

Many engineers are firmly of the opinion that lacing must be used on belts exposed to steam, like those used on pulleys in laundries, etc., as they believe that belt cement will not hold under such conditions. That depends on the kind of cement used. Not all belt cements are made of the same ingredients. Steam will not dissolve a belt cement made on a pyroxylin base, because it is waterproof, and therefore not affected by moisture.



Methods in a Tractor Engine Plant

Battery of Drilling Machines Arranged for Continuous Operation

REPEATED reference has been made in the columns of MACHINERY to the increased rates of production which may be attained through the use of equipment that provides for the performance of machining operations according to the so-called continuous principle, that is to say, a method of procedure that reduces non-productive time of the machines and their operators to a minimum. An ingenious application of this continuous principle has been worked out in the Avery Co.'s engine plant, Milwaukee, Wis., for performing drilling and reaming operations in valve stem guides.

The equipment developed for this purpose is illustrated in Figs. 1, 2, and 3; referring to Fig. 1 it will be seen that there are eight vertical drilling machines of the standard type built by the F. W. Lindgren Co., Rockford, Ill., mounted around the circumference of a special turntable *A*, which is arranged to rotate continuously. This table is driven by an electric motor mounted beneath the floor, and there is a set of change-gears in the driving train, to provide for rotating the table at various rates of speed. The same electric motor that rotates the turntable also furnishes power to drive the individual machines. For rotating the table, the power is carried through a triple reduction gear to give a sufficiently slow speed. The drive to the drilling machine spindles is through a single reduction gear, and thence to a gear at the top of a vertical shaft at the center of the turntable, which meshes with a driving gear at the base of each drilling machine. This gear at the center of the turntable continues to mesh with the driving gears on the machines as the turntable carries them around their circular line of travel. Alternate machines on the turntable carry a twist drill in the spindle, and the other machines carry a reamer, and each work-holding fixture is provided with a pilot that enters a locating bushing in the drilling machine table to center the work under the spindle of the machine. This equipment was designed and built under the personal supervision of James H. Pinson, manager of the Avery plant.

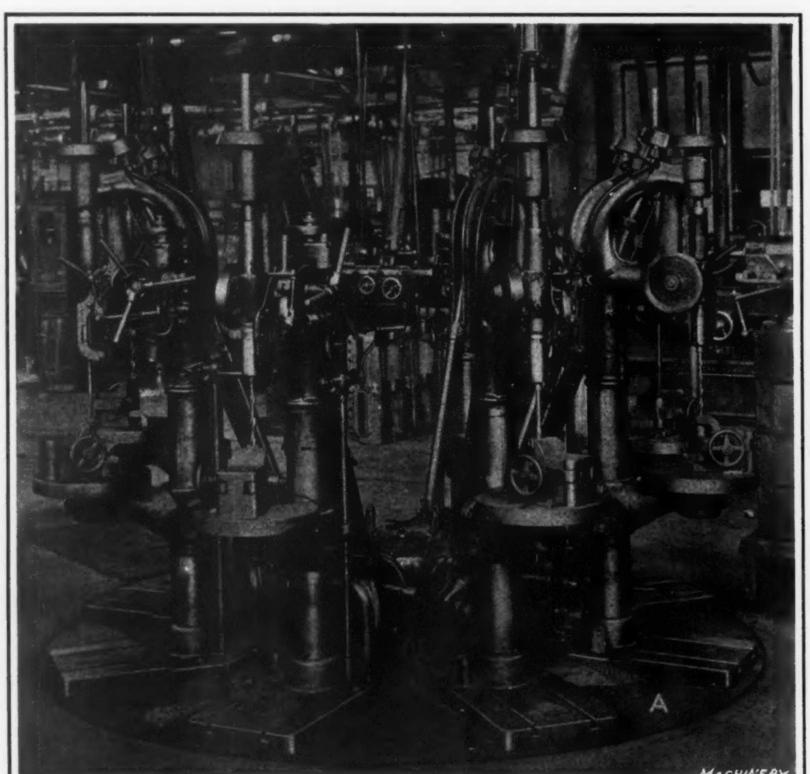


Fig. 1. Special Arrangement of a Battery of Drilling Machines equipped for Continuous Operation in drilling and reaming Valve-stem Guides

Interchangeable Fixtures which Obviate Necessity of Resetting Work for Reaming

All of the fixtures are interchangeable between the machine tables, so that after the drilling operation has been completed in a piece of work, it is not necessary to unload the piece from a drilling fixture and reload it in the reaming fixture. Instead, the method of procedure is to lift the work and fixture as a unit from the table of the drilling machine, enter the pilot into a locating hole on the table of the next machine that carries a reamer, give the fixture about one-eighth turn to clamp it with a bayonet locking mechanism, and then pull down a lever that engages the feed mechanism on the machine. After this has been done, the operator's attention is no longer required until the machine has completed its traverse around the circuit on the turntable *A*. During this cycle, the machine will feed the reamer down to the end of its stroke and engage an automatic trip that returns it to the starting position, so that when the finished piece of work gets back to the loading station of the battery, the operator merely lifts the fixture off the table, drops another loaded fixture into place, and engages the power feed.

Extra fixtures used in this way enable the attendant to occupy his time in unloading finished pieces of work and in setting up fresh castings in their places, so that these loaded fixtures can be set into position as soon as there is a

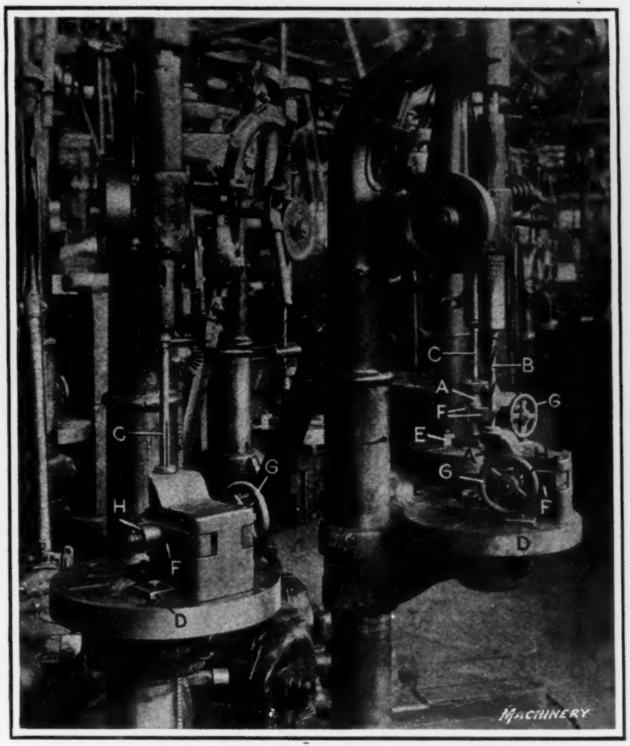


Fig. 2. Close-up View of a Drilling and a Reaming Machine showing Arrangement of Interchangeable Work-holding Fixtures

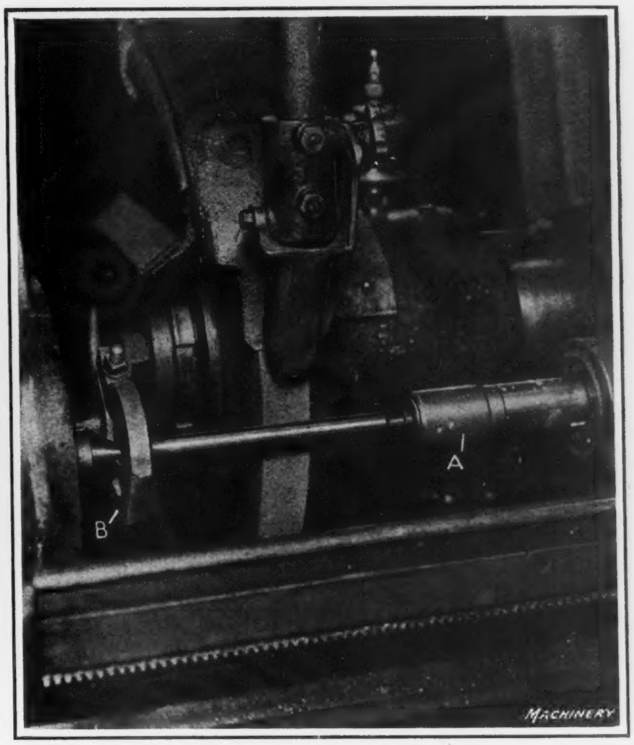


Fig. 3. Special Grinding Machine Center used for holding Tractor Engine Valves for grinding their Stems

place made vacant on one of the drilling machines. As previously stated, the turntable runs continuously, and the work makes two turns around the circuit. At the first turn, the drilling operation is performed; then the fixture holding the drilled piece of work is transferred to the table of a machine in the spindle of which there is a reamer, and it makes another circuit on the turntable in order to have the hole reamed. A fixture containing a drilled piece is transferred from a drilling machine to a reaming machine, and a fixture containing an undrilled casting is set up on the vacant drilling machine table. With such an equipment the operation is essentially continuous, and a gratifying rate of output can be secured.

Arrangement of Fixtures to Facilitate Continuous Operation

Having made this preliminary statement concerning the general procedure in operating this battery of machines, a detailed description can be presented of the equipment. This is best shown in Figs. 1 and 2. Fig. 2 shows a close-up view of two machines, one of which is used for drilling and one for reaming. In this illustration, the work is shown at *A*, while the twist drill for performing the first operation is shown at *B* and the reamer for taking the second cut is illustrated at *C*. It has already been stated that beneath the fixture there is a pilot, shown in Fig. 4, that is interchangeable in locating holes in all of the drilling and reaming machine tables, so that any fixture will fit any table. The fixture is dropped into place with the pilot in the hole, after which it is turned until further movement is prevented by engagement of the side of the fixture with a stop *D*, Fig. 2, and at the same time an extension on the base of the fixture has slipped under a bayonet lock *E* that holds it down in place.

Method of Clamping the Work

Clamping of the work *A* is accomplished by means of two jaws *F* actuated by a handwheel *G*. It will be seen that the work *A* has a small collar on it, and this collar prevents the

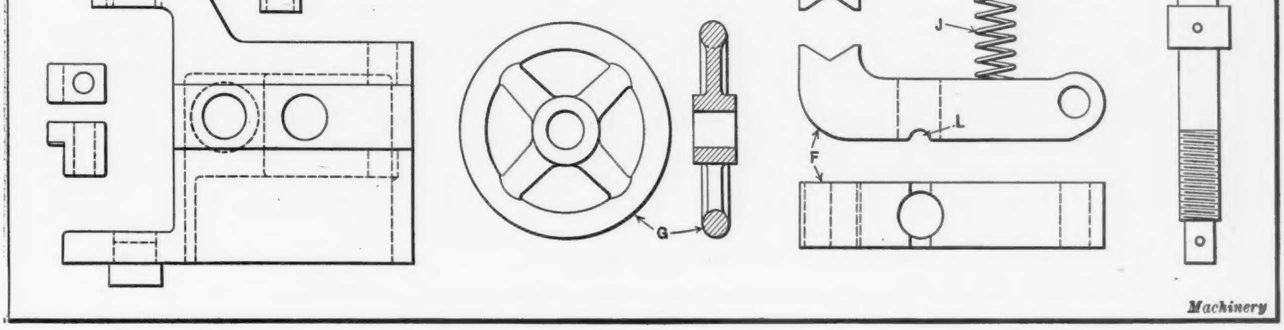


Fig. 4. Details of the Interchangeable Work-holding Fixtures used on Machines shown in Figs. 1 and 2

work from slipping through the jaws before they are completely tightened. Handwheel *G* actuates a screw that is threaded right-hand at one end and left-hand at the other, so that rotation of the handwheel results in turning this screw and drawing in two nuts *H* that pull jaws *F* together to grip the work.

From Figs. 2 and 4 it will be apparent that jaws *F* are pivoted at the back of the fixture, and in order to clamp the work, they must swing about their pivotal supports, thus changing their angular position. The nuts *H* engage the outside of the jaws, and this change in angularity would result in failure of the nuts to bear uniformly on the jaws unless special precautions were taken to compensate for this objectionable tendency. The means that were adopted for this purpose are illustrated in Fig. 4. It will be seen that the nuts *H* are furnished with a convex semi-cylindrical fulcrum point *I* that enters a corresponding concave semi-cylindrical bearing in the outside wall of jaw *F*. In this way the bearing between each nut and the jaw is between the fulcrum *I* and bearing *L*, and as a result changes in the angular position of the jaws do not affect the uniformity of the bearing between the nuts *H* and the jaws. A spring *J* which fits into pocket *K* opens the jaws when handwheel *G* is turned to release the clamping nuts *H*.

Special Tail-center for Holding Valves while Grinding the Stem

After the valves for Avery tractor engines have been machined, they are casehardened, and the stems are then finished to size by grinding. For the performance of this grinding operation, a practice was formerly made of leaving a small amount of excess metal at the lower end of the valve-stem, in order that a center hole could be machined in this metal to receive the tail-center of the grinding machine; and after the stem of the valve had been ground, this excess metal was broken off and the lower end of the valve-stem faced off smooth on a grinding wheel.

So far as the performance of the grinding operation was concerned, this practice was entirely satisfactory, but experience showed that when the excess metal carrying the hole for the tail-center was removed, the bottom of the valve-stem was no longer protected by an outer surface of carburized and hardened steel, and as a result it soon became battered through the action of the lifter-rod. Evidently, such a condition was undesirable, and Fig. 3 shows the means that were ultimately developed for overcoming the difficulty. The end of the valve stem is now chamfered and fits into a conical-shaped cup-center *A* that is provided with roller bearings to support the thrust, so that frictional resistance between this rotating member and the stationary body of the center is reduced to a minimum. At the opposite end of the valve-stem, it will be seen that an ordinary driving dog *B* is used to rotate the work, and the operation, aside from the method of supporting the tail end of the work, is quite an ordinary job of cylindrical grinding.

* * *

On January 1, 1920, a law went into effect in Sweden, providing for an eight-hour day in all the industries, and prohibiting over-time except under certain conditions for which special license was required. This law has not met with the favor either of the employer or of the workman, and a special government commission has investigated its operation with the result that it has been recommended that the law be suspended and revised. The commission recommends that the length of the working day be made dependent upon mutual agreement between employers and employes, and that provision be made for working over-time whenever circumstances make this necessary. The commission further found that in no industry had the shorter working day produced greater efficiency on the part of the employes, and there had been a considerable decline in production, several large plants being on the verge of closing down due to their inability to earn enough to meet the increased costs.

PROLONGING LIFE OF DIES

A patent has been issued to H. R. Reinhardt for a method of prolonging the life of dies, punches, and other similar tools for drop-forging and heading operations. The method was recently described in an article that appeared in the *American Drop Forger*, and is based on the fact that tools of this type will withstand wear better and last longer if, while being used, they are kept heated at a temperature above that of the atmosphere and lower than that used in the heating process. Roughly speaking, the temperatures used in the method, vary from 300 to 1100 degrees F., depending upon the characteristics of the steel from which the die or tool is made. Some specially compounded steels may be kept at a higher temperature than the maximum stated, but it must be somewhat less than that used in hardening.

Determination of the proper temperature requires a knowledge of the composition of the steel or of the hardening temperature, and this information can generally be obtained from the manufacturer of the steel. In using the method in connection with ordinary straight carbon tool steels largely used for drop-forging dies, that is, steel containing from 0.75 to 0.90 per cent carbon, which is heated to from 1400 to 1475 degrees F. in hardening, and whose tempering heat does not exceed 750 degrees F., a very high degree of toughness and resistance to wear is imparted to the tool by keeping it at a temperature of from 400 to 500 degrees F. while it is being used. In this instance, the lighter the dropping weight of the machine in which the tool is being used, or the lighter the stock and the easier the flow of the metal, the nearer to the stated lower limit the tool may be heated. It is preferable to keep tools made from carbon steels at a lower temperature than those made from alloy steels, because the continuous application of the former at a temperature nearer to that used in the hardening process, will result in a reduction of their hardness.

Dies or tools made of chrome-nickel, carbon-chromium, chrome-vanadium, cobalt-chromium, tungsten, or molybdenum steel alloys will, in some cases, scarcely be affected by temperatures ranging up to 1100 degrees F. Tools made of tungsten high-speed steel for heavy forging, trimming, and blanking operations will give much longer service if heated to this temperature, the period of their usable condition being more than doubled. Tools made of the cheaper grades of high-speed steels, not containing tungsten, may be kept at a temperature of 850 degrees F. without losing the required degree of hardness.

Heating the tools and dies and maintaining the temperature while being used may be effected in various ways. One method, which serves well for all temperatures, is to apply to the tool or die, a jacket tightly packed with a suitable layer of infusible earth or fine molding sand, and then heat it through the use of gas burners. In this way, the tool can be heated uniformly and kept near the requisite temperature for hours. An electrically heated apparatus could also be employed. Where it is more convenient and the tool does not require to be heated above 600 degrees F., an oil, molten lead, or lead and tin bath may be used.

In this connection, it may be noted that a compound of fourteen parts of lead to eight parts of tin melts at about 420 degrees F. and a combination of thirty-eight parts of lead with eight parts of tin, at about 510 degrees F. These temperatures are required frequently, and the molten condition of the compounds serves to indicate the temperature of the tool. The heating of the tool and of the packing or bath is controlled by means of a suitable instrument set in a recess in the tool, packing, or bath, and provision may be made for continuously indicating the temperature of the tool by providing a suitable temperature-indicating instrument. The inventor claims that high-speed steel die-blocks are so tough under a maintained heat that, without losing the essential hardness, they will bend rather than break and crystallization seems to be entirely eliminated.

Increasing Production by a Rational Piece-work System

By JOHN C. SPENCE, Superintendent Grinding Machine Division, Norton Co., Worcester, Mass.

IN a former article, in the December number of MACHINERY, it was mentioned that one of the causes for curtailed production was willful restriction on the part of the worker. This restriction can be practically eliminated by the management of any shop where the latter, rather than a trade union, has the right to determine the methods whereby the work in the shop is to be performed.

During the years of the writer's experience with shop men, he has found that two classes of workers are inclined to restrict output: First, day workers who appear to believe that whenever they can loaf a little there is some peculiar gain to themselves, and who also appear to think that as piece-work prices sometime may be set on the work that they do, it may be advisable not to speed up production too much; and second, piece-workers who are afraid that if they earn "too much," piece-work prices will be cut or some new method devised for doing the work which will make it convenient to introduce a new price.

Piece-work the Best Plan for Increased Production

Piece-work plans of some kind offer the best means for stimulating the day worker to increase his efforts and thereby increase production. In discussing this subject, I confess that my sympathies are more with the worker than with the old-type executive, and that the objection of workmen to piece-work plans is largely due to the methods applied in the past in this connection. "Unscientific" and "unscrupulous" are the words that best describe piece-work rate settings of the past, and it will take a long time before the worker will really gain that confidence in the management which is found only in a few plants throughout the country, and which has been created by absolutely fair dealings in connection with piece-work. The only method whereby it is possible to make men produce to the full extent of their ability, consistent with health, is to make them confident that no matter how much they earn through increased speed, piece rates will not be reduced except upon fair principles.

Past Experiences Showing Possibilities of Increased Production

Since 1914, piece-workers in many cases have doubled their output and have consequently doubled their wages, because piece-work prices are practically the same now as in 1914. This 100 per cent increase in production has been possible because of the fact that the cost of living and the price of labor went up, and the piece-worker was able to increase his speed and his earnings without danger of having the piece rates cut. The result was twice the production and twice the wages, but the direct labor cost was not increased. If on the other hand, there should be a reduction in wages, it is likely that there will be a gradual reduction in the production of piece-workers, because they will naturally adapt themselves to a figure that they believe the management will not call "too much" in regard to their earnings. It is here that the writer believes that the greatest opportunity lies for a live management to obtain one of the great benefits of the war. In taking advantage of this opportunity, a plan such as outlined in the following will serve at least as a guide.

The "Proving" or "Trial" Department

A part of the shop is set aside as a "proving" or "trial" department. One or more of each of the principal machines used in the shop are placed in this department and some of the best men in the shop are sent to operate these machines. Assuming that the men operating the machines in this department are of such quality as would be satisfactory to the management, if the whole shop were manned by men of this type, it would be reasonable to assume that their output could be considered a fair measure of a fair day's output for any man in the shop; and the management must be prepared to be satisfied with the output of these men, which is checked for errors by a good foreman and a rate-setting department. The output from this department should be called "a standard day's work" or "a fair day's work" and the hourly rates should be so set that a "fair day's pay" would be paid to the men in this department.

When the proving department has performed an operation that seems reasonable to the rate setters, a piece-work price should be set by dividing the hourly rate of the men in this department by the number of pieces completed by them per hour. This gives a fair piece-work price for the type of man that it is desirable to fill the shop with. Sometimes there may be a few piece prices that are too high, but even in that case a good deal is to be gained by the management if no change is made, as the men will appreciate that the management will stick to its word.

Complaints that Piece-work Prices are too Low

If the proving department is properly on the job, there will doubtless be a great many prices that the shopmen will consider too low. In order to meet this condition, a record should be kept of all piece-workers, and an investigation should be made of the work of all those who earn less than, say, 80 per cent of what has been estimated to be a fair day's pay. Let the proving department again do the jobs on which the men in the shop had failed, and then let the man who did the job in the proving department go to the man who failed in the shop and show him how he can earn more money. Should it turn out that the proving department cannot make good on the second trial, it is evident that the price is too low and that it should be raised.

What is a Fair Day's Pay?

The most difficult problem of all is to determine what is a fair day's pay. The only rational basis that we have at present to base any opinion upon is the cost of living. The fair day's pay should be based upon the cost of a list of common necessities, well defined, so that prices may be obtained for comparison over any period of years. Indefinite items such as rent and clothing can be omitted, because these may safely be said to vary directly with some of the necessities that can be definitely priced. By such a comparison of the cost of necessities, an index figure can be obtained which may be used as a standard. If this index figure shows that the cost of living has gone up 10 or 20 per cent, there will have to be a corresponding raise in piece-work prices. If the index figure goes down, circumstances may determine whether or not it is deemed advisable to reduce the piece-work rates.

If the management of an industrial plant would openly and frankly discuss this question of reduction of piece-work rates, and present definite reasons why a reduction is not only justified, but necessary, there would be less trouble from

lack of confidence on the part of the workers toward the management. Furthermore, if the related industries of a community were governed by such definite facts in their wage-paying policy, and always submitted definite proofs of any action taken in regard to wages, there would be less labor trouble.

Full Information and Open and Aboveboard Methods are Necessary

The workers should receive full information relating to the methods used for setting and changing rates, and should be made to understand that while on account of lack of facilities all piece-work cannot be set by the proving department, the latter will sooner or later try every operation in order to determine whether or not the piece rates once set are fair both to the management and to the workers. Meanwhile, the worker should be guaranteed that no piece price will be changed unless it has actually been demonstrated by the proving department that it is erroneous. With this assurance, the workers will know that as the proving department will some day try each operation, they can gain nothing by holding back, but can earn a great deal more by exerting themselves in accordance with their ability.

When the workers realize that if piece-work prices are set too low, the rates will be investigated upon request and corrected and that other piece rates will not be cut just as soon as the operator shows an ability to earn a high wage, there will be astounding increases in production.

Many managers do not seem to realize that the man who earns the highest pay on a piece-work basis is the best man in the shop, other things being equal. Why should that man be penalized by having his rate cut? Most managers will say that it is done in order to equalize the pay between the men and that excessive earnings on the part of one man cause dissatisfaction and friction. This appears to be wrong reasoning. When the earnings are based on actual results, the other workers realize that the man who earns a high pay is an exceptional worker, and they will think more of the management that permits this man to continue to make his high rate of pay without a cut, than they will of the management that tries to force him down to the level of the rest.

* * *

STANDARDIZATION OF SCREW THREAD SYSTEMS

In a lecture given by Sir Richard Glazebrook, late director of the National Physical Laboratory at Teddington, England, before the Institution of Mechanical Engineers, the lecturer dealt with the possibility of obtaining uniformity in screw thread systems in England and in America. Experiment has shown that for many purposes the U. S. threads are interchangeable with the Whitworth thread, provided the pitches are the same, and with one exception, the pitches of the American series agree with the British standard Whitworth system. The one exception is the half-inch, for which a pitch of 13 threads is now standard in America in place of the original 12 threads of the Whitworth system. The hope was expressed that it is not too late to ask American manufacturers to reconsider this point and thus secure uniformity. With the fine threads, the case is different. The American Commission has adopted as standard the series standardized by the Society of Automotive Engineers, which are in all cases from 2 to 4 threads per inch finer than the British standard fine series. Here again the hope was expressed that steps would be taken to bring about uniformity before British manufacturers are irretrievably wedded to either series. The lecturer also took the view that the limits suitable for various classes of work are fairly definite and do not depend on the nationality of the manufacturer. It is hoped that as far as possible all nations will adopt the same limits for such articles as screws and nuts for the parts of automobiles and for other machinery that has a wide area of distribution.

USING ALUNDUM AS A POLISHING ABRASIVE

The abrasive action of any polishing grain is dependent upon the amount of crystalline aluminum oxide present, says a recent issue of *Grits and Grinds* in which the suitability of alundum as a polishing abrasive is discussed. It is stated that alundum contains about 92 per cent crystalline aluminum oxide, whereas the best grades of Turkish emery contain at the most 65 per cent corundum, which is the form in which crystalline aluminum oxide occurs in emery.

A large percentage of the impurities in emery is magnetic iron oxide which is mixed in the grains of emery and makes them porous. On the other hand, alundum grains are solid and tough crystals. Since emery is a natural mineral, its quality varies a great deal, but as alundum is a manufactured product, it can be held to a uniform formula, and the crystal structure and percentage of aluminum oxide held within close limits. These properties have their effects on the use of abrasives for polishing wheels. Emery, because of its low corundum content and porosity of the grains, is not strong enough to remove a large chip, but breaks off more quickly than electrically fused aluminum oxide. Because of this, emery wheels do not give the production possible with alundum wheels.

Preparing Glue for Polishing Wheels

Maximum production can be obtained with alundum grain only by the use of a good glue and by the proper application of the glue and grain to the wheel. With a little care exercised along these lines the production per wheel has been increased from 100 to 500 per cent. When a weak glue is used, many abrasive particles are thrown off before their full value has been obtained. Either flake or powdered glue should be used, there being various kinds of glue on the market especially manufactured for setting up abrasive polishing wheels.

Ground glue should be soaked in cold water for about two hours, and flake or sheet glue over night. The common mixture is one pound of glue mixed with one pound of water. This formula can be changed to make a thicker or thinner glue to meet conditions. Cooking is best done in a pot surrounded by a hot water bath, the temperature never being allowed to exceed 160 degrees F. Glue cookers having automatic temperature controls can be obtained, and their use is recommended where considerable polishing is done.

The glue should be cooked from one and one-half to two hours at a temperature of between 150 and 160 degrees F. It can then be cooled to between 130 and 140 degrees F. and used. Only enough glue for use during one day should be mixed, as glue that has been allowed to stand hot for ten hours, then cooled over night and reheated in the morning, is of no value. The glue remaining in the pot each night should be thrown away and the pot thoroughly washed before putting the glue to soak for the next day. Wheels are best set up in a room assigned for this purpose, the glue being applied to the wheel by using a brush. The wheel is then rolled in the alundum contained in a long box.

Preparing the Abrasive and Drying the Wheels

The alundum should be heated so that it will not chill the glue when applied, as chilled glue loses some of its holding power. A convenient way of heating the abrasive is to have steam-pipes run through the bottom of the box in which it is contained. Cold air drafts should not be permitted to blow through the set-up room.

After the wheels have been set up and the abrasive pounded into the wheel face, they should be hung up in a drying room for at least twelve hours. Good results cannot be obtained by using wheels that have not been properly dried as the wheels gum over and cannot be used as long as if they were in proper condition. Best results are obtained when the wheels are allowed to dry for twenty-four hours.

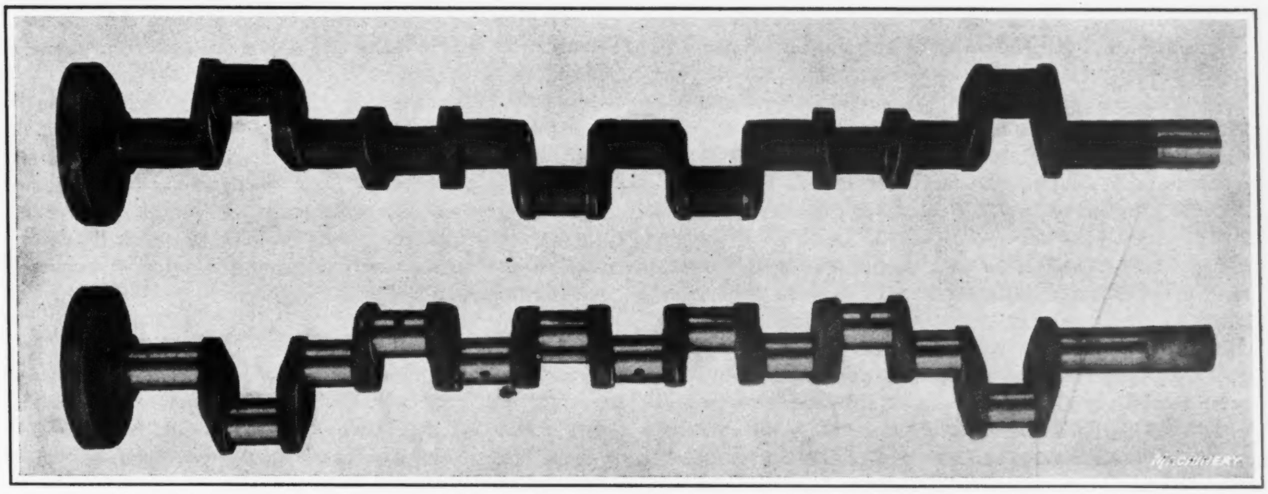


Fig. 1. (Upper View) Crankshaft Ready for Copper-plating Process, the Bearings having been covered with Tape. (Lower View) Crankshaft after the Webs and Ends have been copper-plated to prevent Carburization

Heat-treatment of Low-carbon Steel Automobile Crankshafts

Practice of the H. H. Franklin Mfg. Co., Syracuse, N. Y., in the Heat-treatment of Crankshafts, Including the Copper-plating, Carburizing, and Hardening Operations

By FRANKLIN D. JONES

THE use of casehardened crankshafts in the motors of Franklin cars is a recent change that is a departure from the general practice among automobile manufacturers. The chief reason for using low-carbon steel crankshafts, which are casehardened, is to obtain harder and more durable bearing surfaces than are found on the crankshafts commonly used in the construction of passenger cars. Tests have shown that a casehardened crankshaft will run 50,000 miles, or the equivalent of that distance in revolutions, without readjustment of either the connecting-rod or the main-line bearings. In other words, the hardened crankshaft practically resists all wear during the life of the motor, or at least, wear that seriously affects the motor's operation.

The steel used in these new crankshafts has a carbon content of about 0.20 per cent, and about 0.45 per cent of manganese, and conforms to the S. A. E. specification No. 1020. The crankshafts made of this steel are machined as close to size as practicable before heat-treatment, and then after the carburizing and hardening operations, the bearing surfaces are ground to size, and the flanged and threaded ends are finished, thus insuring accurate alignment.

Copper-plating the Crankshafts

The first operation on the rough drop-forged crankshafts is sand-blasting, the object being to remove all scale and rust preparatory to the copper-plating process. The car-

Fig. 2. One of the Tanks employed for the copper-plating of the Crankshafts

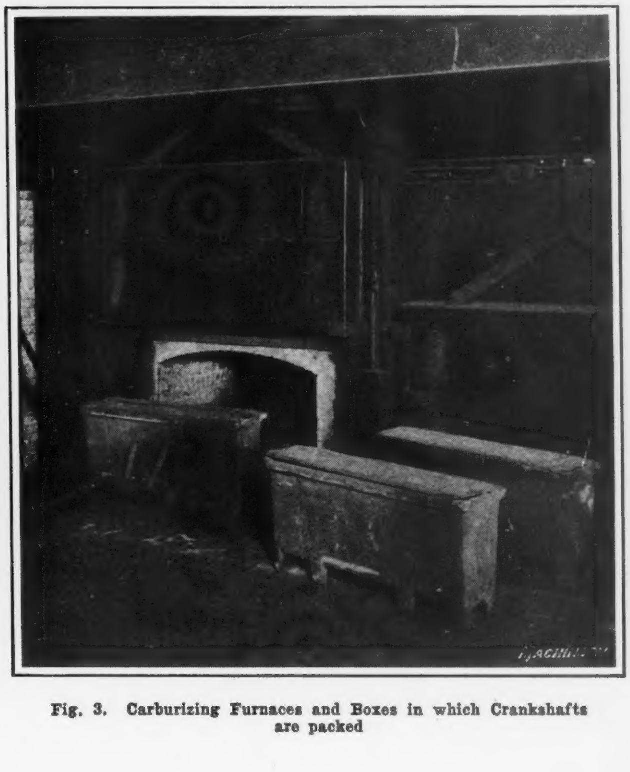


Fig. 3. Carburizing Furnaces and Boxes in which Crankshafts are packed

burizing and hardening is confined to the bearing surfaces of the crankshaft, the idea being to harden only those surfaces that are subject to wear. By leaving the other sections soft, the toughness and elastic properties of the unheat-treated forgings are retained. In order to prevent the sections other than the bearings from becoming carburized, different kinds of protective coatings were tested, and copper-plating was found to be superior to any of the other methods employed.

The first step in connection with copper-plating the crankshafts is to cover the bearing surfaces to prevent them from receiving a copper coating. Ordinary electricians' tape may be used for this purpose, as illustrated in Fig. 1 (upper view), which shows a crankshaft with the bearings covered, ready for the copper-plating process. The lower view of the same illustration shows a crankshaft after the webs and end sections have been plated and the tape has been removed from the bearings. Another method of protecting the bearings against copper-plating is by means of hinged steel clamps or sleeves having rubber linings. These rubber linings prevent the bearing surfaces from coming into contact with the plating solution, and they also insulate the steel clamps against the action of the electric current so that the clamps are not plated. These rubber-lined clamps can be applied to the crankshafts more rapidly than the tape and are to supersede the use of tape.

When the bearings have been properly covered, the crankshafts are thoroughly cleaned by immersing them in an alkaline solution. This bath is steam-heated and has an electric current passing through it, which, by generating hydrogen gas, greatly assists in removing any oil or greasy substances from the surfaces. The crankshafts are next washed in cold water, and are then immersed for a few minutes in a bath of diluted muriatic acid. After another immersion in the cold water tank, they are ready for copper-plating.

One of the plating tanks is illustrated in Fig. 2. Two crankshafts are placed in this tank at one time. They are suspended on hooks in the plating solution, between the anodes or copper plates, which may be seen in the illustration, extending slightly above the surface of the solution. These plates supply the copper which is gradually deposited upon the work by the action of an electric current of 200 amperes and 2 or 3 volts. This current passes from the copper plates to the crankshafts, and then through the hooks holding the crankshafts to the cross-bars, which connect with the return wires. The solution in the tank is heated by a steam coil to accelerate the plating process. A coating of copper varying from 0.0025 to 0.003 inch thick is deposited upon the unprotected surfaces of the crankshaft in from forty to sixty minutes. This is a thick enough coating to resist the action of the carburizing compound during the heat-treating operations that follow.

Carburizing the Crankshafts

After the crankshafts are copper-plated, they are ready to have the bearings carburized. The carburizing boxes and the furnaces used for this purpose are shown in Fig. 3. Each of these boxes holds two crankshafts, and each furnace has a capacity for fourteen shafts. The crankshafts are carburized to a depth of about 1/16 inch, which requires from twenty to twenty-two hours, and a temperature ranging between 1650 and 1700 degrees F. The crankshafts are allowed to cool in the boxes; then, after the straightening operation, they are sent to the machine shop for removing the surfaces of the flanged and threaded ends, for although these surfaces were copper-plated, they are liable to be slightly carburized, and are removed by machining to permit readily refacing the flange and finishing the thread after the hardening operation; the flange and threaded end will then be in perfect alignment with the bearings which are finished by grinding after hardening.

The crankshafts are now ready for the final heat-treatment, which consists of heating them for approximately three hours to a temperature of about 1450 degrees F., and then quenching in water to harden the carburized surfaces. In order to prevent excessive springing or distortion of the crankshaft at the time of quenching, it is held in a special fixture or "hardening die," which is shown in Fig. 4, with a crankshaft in place, ready to lower into the quenching bath. This die or fixture is of very heavy construction, and it is provided with hardened steel V-blocks, which grip all of the main-line and crankpin bearings in order to hold the shaft rigidly and prevent it from springing excessively when

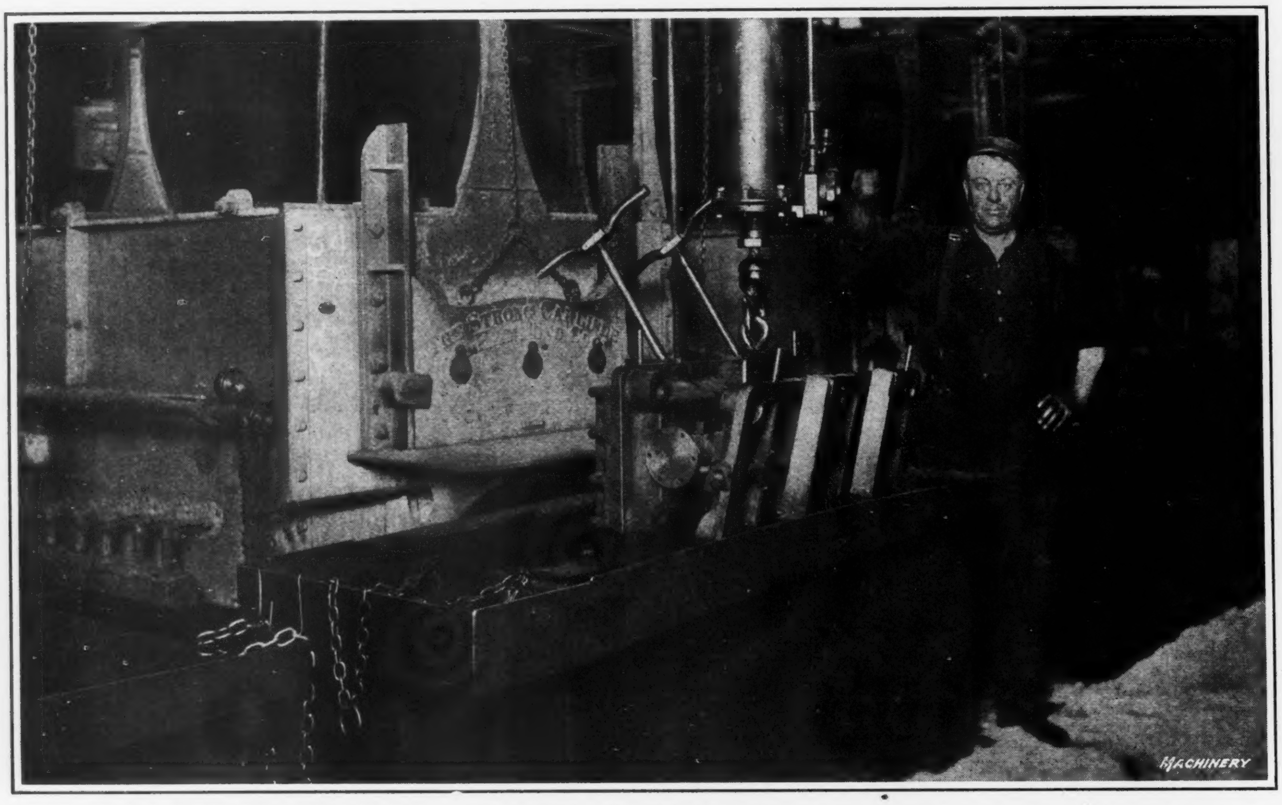


Fig. 4. Special Fixture or Hardening Die which grips the Crankshaft to prevent Distortion when it is quenched for hardening

immersed in the bath of water. This hardening die has a hinged cover and quick-acting clamps, so that the red-hot crankshaft can be withdrawn from the furnace, placed in the die and submerged in the water about twenty-five seconds. As the clamping blocks are V-shaped, practically a line contact is obtained, so that there are no soft spots large enough to affect the wearing qualities of the bearings. These crankshafts are hardened to a scleroscope reading of 75 to 85.

The carburizing operation does not affect the length of the shaft particularly, but there is a rather decided longitudinal shrinkage as a result of the final quenching after hardening; but as this is fairly uniform, it is controlled readily by making a suitable allowance when machining the crankshaft. Both the main-line and crank or "throw" bearings are finished by grinding. An allowance of about 0.035 inch is left for this final grinding operation to care for the distortion of the shaft that often takes place during heat-treatment.

The heat-treating department of the Franklin plant is exceptional, both in regard to the completeness of the equipment and its arrangement. One of the important features in any heat-treating department is the means provided for quenching. In the Franklin heat-treating department there is a complete and satisfactory system for furnishing the quenching tanks with an ample supply of oil or water, as the case may be. One of these quenching tanks is located in front of each of the hardening furnaces (see Fig. 4). At the bottom of each tank there are two parallel pipes connected with the supply pipe and provided with numerous perforations so that the cooling oil (or water) is uniformly distributed as it enters. When the tank overflows, the surplus is caught by a large channel or trough surrounding the top, and is conveyed to the outlet at one end, where there is a conical-shaped screen for catching all dirt or foreign material. This return pipe conveys the heated oil to a pump which forces it through a series of cooling coils suspended beneath the roof. These coils consist of oil-pipes surrounded by larger pipes which are filled with cooling water. After the oil passes through these coils, it flows back to the storage tank from which it is again pumped to the various quenching tanks.

* * *

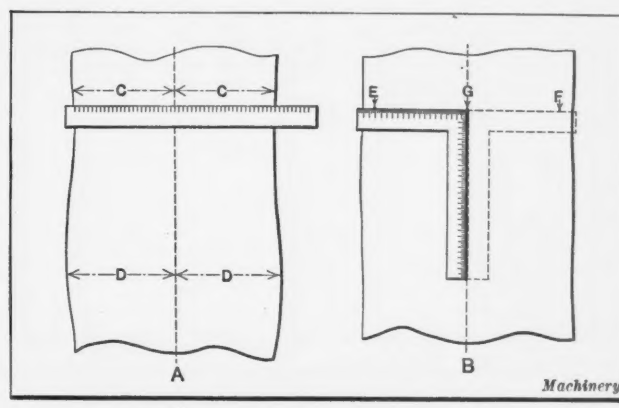
SQUARE ENDS FOR BELTS

Cutting the ends of a belt when putting it into service seems such a simple thing that often the operation does not receive the consideration necessary to insure efficient working of the belt, and, as a result, much of the difficulty experienced with otherwise good belts can be traced directly to the fact that their ends are not cut and joined accurately. It is just as easy to make a belt joint that will cause the belt to run like one of the endless type as it is to join the ends by careless "rule of thumb" methods. When a belt runs "wobbly," that is, when it slips back and forth across the pulleys, neither its best service nor its longest life is being secured and, of course, a belt that will repeatedly jump off the pulleys cannot be tolerated. If the ends of the belt are cut square and are joined properly, the belt will run straight provided the pulleys are in correct alignment. In the following, a number of useful suggestions given in this connection by the Crescent Belt Fastener Co., New York City, are presented:

A square should always be used in cutting the ends of a belt preparatory to joining them, to insure that they will be cut at a true right angle to the center line of the belt. If a square is not employed, one or both ends are likely to be cut uneven or irregular, and these conditions cause the belt to slip from side to side of the pulley and impose irregular strains on the belt fibers, which no belt can endure indefinitely. Belts of widths up to about 18 inches can be cut sufficiently true by holding one leg of the square against one side of the belt, having the other leg project across the belt, and then cutting along the edge of the latter with a sharp knife held perpendicular to the belt. The knife blade should be wet occasionally to make it cut easily.

The ends of wide belts are more difficult to cut square on account of slight variations in their widths and because the sides may not be exactly parallel; however, satisfactory results are assured by following the method to be described. At any point on the belt near where it is to be cut, measure across and find the center as indicated by dimensions *C* at *A* in the illustration. Then at a point two or three feet back from these dimensions, locate the center again as indicated by dimensions *D*. Between these two points draw a clean sharp line. Next, by holding one leg of a square against the center line just made, trim off one-half of the end of the belt by cutting along the other leg. By laying the square on the other side of the center line, the other half of the belt can be cut. The square should be held firmly in position while cutting the belt, and if two small nails are driven in the belt on the center line, they will help to keep the square from slipping.

In cutting the opposite end of the belt, lay out another center line in the manner described, and at any point on this line other than where the belt clamps will come when joining the ends, locate a point as indicated at *G*. Then, again using the square as illustrated, draw a line *EGF* at right angles to the axis of the belt. It is sometimes easier to draw this line by marking points *E* and *F* and then placing a straightedge through them when drawing the line, but in such a case care should be taken to see that the straightedge is not warped. Do not cut on the line just produced, as it is intended to serve as a base line from which to measure the length of the belt after the latter has been placed in the clamps. The exact point where the belt should be cut can be determined after the clamps have been put on and the belt brought into position. Then, measure forward from line *EF* an equal distance on each side of the belt to the cutting point and scribe a line across the belt at this point. By using calipers, the measurement can be taken over the belt clamp, or by using a scale, it can be taken through the edges of the clamp. As a matter of convenience, always cut one end of the belt square and have it ready for making the joint before putting the belt into the clamps.



Laying out Center Line and Cutting Line on Wide Belt

* * *

DEVELOPING WATER POWER RESOURCES OF THE UNITED STATES

The last session of Congress having passed the water-power bill, the way is now clear for the development of the vast unused water power resources of the country. Heretofore government permits for the development of water-power sites have been revocable at will, and thus the businessman has hesitated to embark upon such ventures. The new water-power bill, however, removes this uncertainty, as licenses will now be granted for a term of fifty years, and at the end of such time may be renewed; or the Government, if it sees fit, may take over the development, giving, of course, proper compensation to the owners.

DIES FOR FORD AUTOMOBILE HUB PLATES

By C. J. HUEBER

An enormous number of hub plates are required daily to meet the needs of the assembling departments in the Ford automobile shops, these parts being of the dimensions shown in Fig. 1. It will be noted that several dimensions must be within specified limits. One manufacturer of these parts produces them on power presses in three operations, and two of the dies used for this purpose are described in the following: The first operation consists of cutting the blank to the outside diameter of the finished part, and is performed on a press equipped with a blanking die of standard construction.

The second operation on the plate consists of piercing a hole 3/4-inch in diameter through the center of the blank, drawing the hub, and rounding one edge of the flange. The punch and die used in this operation is illustrated in Fig. 2. A noteworthy feature of the operation is that the diameter of the flange remains the same as that of the original blank, the hub being drawn from the metal between the inner portion of the flange and the hole pierced through the blank. As a result, it will be seen that the thickness of the metal constituting the hub is considerably less than the thickness of the flange. The hole is punched through the blank prior to drawing the hub, the purpose of the hole being to permit the metal to be drawn more easily near the center of the part without changing the diameter of the flange.

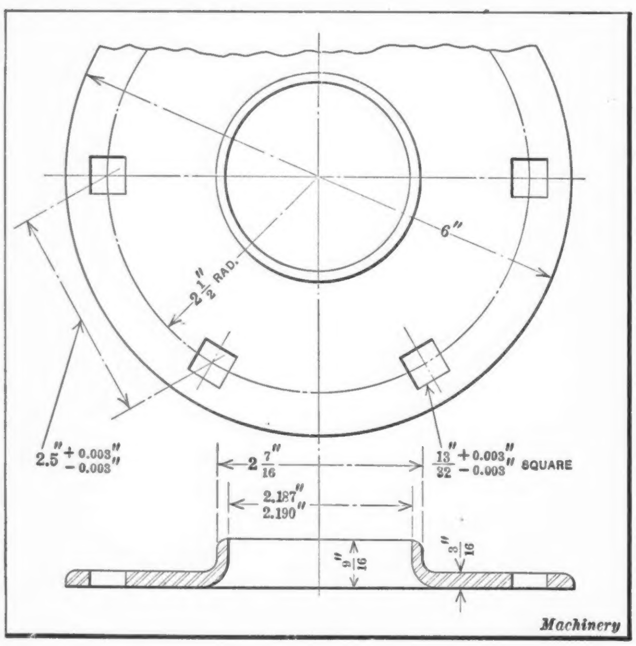


Fig. 1. Hub Plate of Type used on Ford Automobiles

In Fig. 2 the punch is shown in the position occupied at the end of a downward stroke. Prior to an operation, the blank is placed on the draw-ring *A*, which is raised by means of spring *B* and four pins *C* to a position in which its upper face is in alignment with the top surface of the punch *D*. The blank is located in the proper position on the ring by means of a slight recess in the upper face of the ring, which is of the same diameter as the blank. On the downward stroke of the press ram, the piercing punch *E* comes in contact with the blank, and while it is being forced through the blank the forming punch *F* holds the plate against draw-ring *A*, thus insuring that the diameter of the blank will remain unchanged while the hub is being drawn. The upper edge of the flange is rounded by punch *F* as the draw-ring comes in contact with die-block *G* at the end of the stroke.

On the upward stroke of the ram, the blank is stripped from punch *F* by block *H*, to which punch *E* is attached, block *H* being actuated by knock-out rod *J*. The latter is forced down by coming in contact with a cross-bar in the ram. It will be noted that spring *B* is mounted on a tube *K* instead of on a solid rod as is the customary practice.

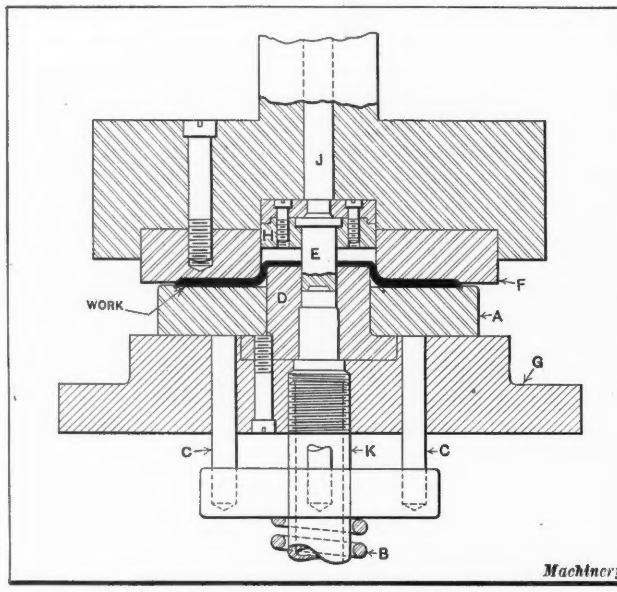


Fig. 2. Piercing and Drawing Die employed to produce Hub on Plate illustrated in Fig. 1

The slugs produced by punch *E* in punching the hole through the plate drop through this tube, and are thus ejected from the die. The press that performs the operation is inclined so that the finished pieces may slide on a conveyor, which carries them to the machine for the next operation.

In the third and final operation on the plate, the large hole is punched through the hub and the six square holes pierced through the flange. The punch and die employed in this operation is illustrated in Fig. 3. It will be seen that punches *A* and *B* are held to the punch proper by plate *C*, which is attached to the punch by means of fillister-head machine screws. Proper location of the blank in the die is obtained by the use of ring *E*. Punch *A* is of such length that, on the downward stroke of the ram, it finishes cutting through the hub just as punches *B* come in contact with the flange. This arrangement reduces the force of the blow on the blank, which would be very great if all the punches came in contact with the work simultaneously, and is a principle that should be adhered to in the design of all heavy piercing dies. It will be seen that holes are provided through the die-blocks *D* and *F* to permit the scrap to fall through the die. The finished part is forced from the punches on the return stroke by stripper plate *G*.

Dies to be used similarly to those described should be of generous proportions and so constructed that they can be easily reground or repaired. The dies described are being used continuously and render satisfactory service.

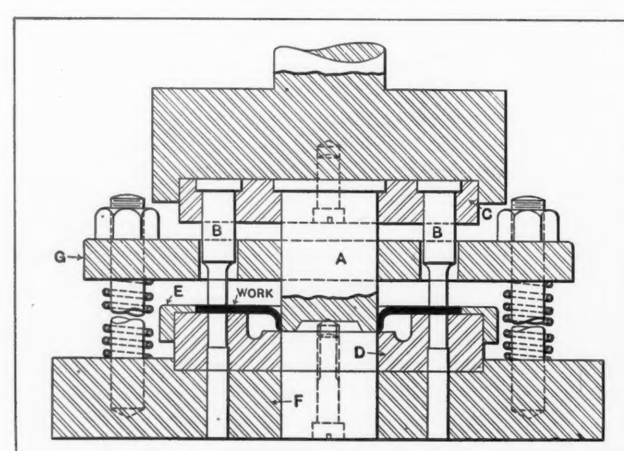


Fig 3. Punch and Die used to punch the Large Hole in the Hub and the Six Square Flange Holes

The British Machine Tool Industry

From MACHINERY'S Special Correspondent

London, January 14, 1921

THE New Year note struck in the engineering trades is one of general depression, considerable unemployment, and short time. Many are expectant that this condition of things will result in a drop in prices, but with the present high cost of labor, fixed charges, and freight such a development seems remote. A falling market in materials appears probable, and this should enable manufacturers to make contracts and take the risk of such fluctuations as may occur.

Perhaps the brightest thing in the whole trade outlook is the greatly improved coal output, due in a large measure to a better spirit among the miners rather than any improvement in equipment. The textile machinery industry remains active, most firms having orders for some time ahead. Locomotive builders and electrical engineering firms are also busy.

Considered as a whole, the machine tool trade remains fairly quiet, and conditions generally are likely to cause anxiety for some time to come. The majority of manufacturing concerns shut down for one, two, or three weeks over Christmas and the New Year, but in many quarters it is not considered that a lengthy period of trade depression is likely, and in fact some very welcome signs are evident that industrial unrest is effecting its own cure. Meanwhile machine tool makers are rapidly clearing off orders on their books, and are securing only a small volume of new business. Short-time working is on the increase, and the hours are likely to be cut even more in the near future, unless there is a substantial improvement in trade generally.

One direction in which any activity of demand is noted is from the railway shops, the Indian and South African companies being the most in evidence, though some of the British railways are active inquirers. Many cancellations are reported in the shipbuilding field, and orders for machine tools from that source are few. Despite the slack conditions now prevailing in the engineering trades, it seems somewhat contradictory to relate that there is still a pronounced shortage of castings. Several users state that, in spite of inquiries soliciting work, they are unable to obtain castings on reasonably quick delivery.

Exports and Imports

The most recent returns show a growing divergence between the import and export tonnage of machine tools; imports dropped to a little over 800 tons in November, whereas exports reached 2800 tons. It is only in the machine tool trade and the trade returns enumerated under "unspecified machinery" that such a favorable discrepancy, to this country, is noticeable. In all other trades a marked decline is seen, if present export and import tonnage is compared with pre-war ratios. However, it is only reasonable to suppose that the condition of the machine tool trade, which may be considered as the prime mover for the majority of the other manufacturing trades, is an index of what may be expected generally as conditions improve.

Foreign competition is becoming more pronounced, and in this connection a comparison of three quotations recently given for a large multiple-spindle machine are of interest. In each case the quotation was for a machine of about the same merit in design, workmanship, and capacity. An English maker quoted £4870 with delivery in eight months; an American firm quoted £4800 with four months' delivery; and a German concern was prepared to deliver in nine months at a price of £3060.

Automobile Trade

The value of automobiles exported annually is now approaching twice that of pre-war trade—four million sterling in 1913—but against this must be set the fact that imports now represent twenty-seven million sterling. At the same time any falling off in the home demand for the larger types of automobiles appears to be counteracted by the increasing demand for the lighter cars with their cheaper running costs. At the moment, however, a slump prevails, and suspensions for from two to three weeks to save expenses are common.

Labor Conditions

Rumor has it that in the northern districts wages in the engineering trades will be reduced by 12½ per cent early this year. Mention has already been made of the improved conditions in the mining industry that may be attributed to a measure of payment by results. It has recently been put to the credit of certain leaders of labor that they at last realize the fallacy of the argument that the less work each man does, the more work there will be to go around and the less unemployment there will be. That realization, perhaps, is due to the incontrovertible logic of the fact that in the year during which there has been least ouput per man there has been the most unemployment.

To quote only one other instance to illustrate the good results that may be expected from the principle of payment by results, Dorman Long & Co., Ltd., of Middlesboro, have been enabled in the past year to extend considerably the application of the principle of payment on tonnage with a sliding scale based on the selling price of the finished material, which has been in operation for some time in their works. They state that both employes and employers have benefited by the higher wages that have been earned and the increased output obtained.

New Machine Tools

Alfred Herbert, Ltd., Coventry, has recently brought out a new universal milling machine. To avoid weakening of the column, the usual cupboard is omitted and a large overhanging arm fits into a tube that braces the main body of the machine. A new worm-gear generator is being produced by Smith & Coventry, Ltd., Manchester. This machine has an interesting type of gear-box, which gives twenty feeds. Another new machine for which this firm is responsible is a ball bearing bench drilling machine, which has spindle speeds up to 10,000 revolutions per minute. The capacity is for holes up to ⅜ inch in diameter.

An interesting type of special machine has been built by J. Tylor & Sons, Ltd., New Southgate, London, for continuously milling motor cylinder block castings. Two vertical milling heads, one roughing and one finishing, are set over a 10-foot turntable weighing 6 tons. The turntable accommodates eleven cylinder block castings, and the rigidity of the system allows a block to be rough- and finish-milled in 1 minute 45 seconds.

A large extension of the Edgwick works of Alfred Herbert, Ltd. has just been completed, which adds 64,800 square feet to the works. These extensions will enable the firm to improve deliveries considerably on its redesigned turret lathes, high-power single-pulley horizontal and vertical milling machines, and the new No. 5 automatic lathe which was exhibited at Olympia. The firm is putting through large lots of the No. 4 turret lathe.

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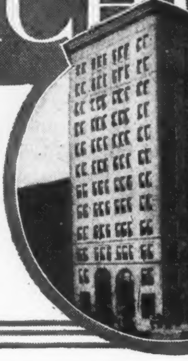

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CANCELLATIONS

The new theory that an order for merchandise can be cancelled at will by the purchaser is undermining the stability of American business, and manufacturers' associations should adopt methods to prevent the continuance of this practice. The past six months have been a contract-breaking period never before paralleled in this country, for cancelled orders have run into hundreds of millions of dollars. While an accepted order is usually a legal contract that can be enforced in court if the seller so elects, most American business men prefer to take a loss rather than to sue a customer, and manufacturers have generally accepted the cancellations and pocketed their losses. But old ideals in regard to the sanctity of a contract underlie the foundations of business, and they should be re-established without delay. No industry that allows contracts to be broken with impunity by either the buyer or the seller can continue on a safe and permanent basis so long as that practice prevails.

In the machine tool industry alone the minimum amount of cancellations is placed at \$25,000,000; the maximum at \$50,000,000. The belief appears to have become general with some machine tool purchasers that it is allowable to cancel an order without regard to the amount of work done on it, leaving the manufacturer to foot the loss. Unavoidable delay in shipment is not a valid cause for canceling an order for a machine, any more than delay in the completion of a building is cause for the cancellation of such a contract. There is hardly a manufactured product into which so many factors enter to cause delay and to make control of the delivery date impossible as in the building of machine tools, and every user knows it. Yet some buyers have taken advantage of the least delay in delivery to cancel their orders, although a reasonable time allowance is only fair and what they would expect themselves, especially when the builder clearly acted in good faith and tried his utmost to live up to his contract. The golden rule is a mighty good standard, and often pays in dollars.

* * *

THE LOCOMOTIVE REPAIR SHOP THE KEY TO THE TRANSPORTATION PROBLEM

One reason our railroads find it difficult to cope with the traffic requirements of the country is that they lack locomotives. During pre-war years, American railroads acquired approximately 3000 new locomotives annually. In 1917 and 1918 the number acquired each year was less than 2500, and in 1919 the three leading locomotive building companies constructed less than 1000 locomotives for the standard gage steam railroads in the United States. These companies supply at least 75 per cent of all the locomotives used on such roads and their figures indicate a shortage at the present time of more than 2500 locomotives. The railroads acquired during 1920 about 1800 new locomotives at a cost of more than \$100,000,000, so that, even this year there will be a shortage of new locomotives as compared with pre-war figures, and because of this shortage more service must be obtained from the locomotives now available.

There are several ways in which this can be accomplished, but the most important is that the locomotives now in use be kept in first-class condition through efficiently managed and well equipped repair shops. It is fully as important that the railroads appropriate some of their millions for new and up-to-date equipment for their repair shops as for new locomotives. If the latter are not kept in service with a minimum loss of time due to breakdowns, the available motive power will not increase in proportion to the outlay.

A locomotive held in the repair shop longer than absolutely necessary because of lack of proper machine tool equipment represents a double loss—one on the investment, earning nothing, another on the shipments which may be held up in the plants waiting for the material. Evidently the repair shop is the key to the situation.

* * *

THE METRIC AGITATION

Bills introduced into the United States Senate by Senator Frelinghuysen of New Jersey and in the House by Representative Britten of Illinois for the establishment of the metric system in the United States indicate that the advocates of the metric system did not become discouraged by the solid opposition of manufacturers that was offered to the measure when it was introduced last year. MACHINERY's position on this vital question was stated in detail in the editorial entitled "Inches versus Millimeters" in the April, 1920, number, and from this editorial we quote the following paragraphs which summarize the position taken by the manufacturing interests of the country:

"A change in the system of weights and measures is not a question for Congress to decide without hearing the opinions of manufacturers who are vitally interested. Members of Congress, however able, lack the special practical experience required to pass upon a question of such moment to our industries. The system of measurement used in engineering and industrial work is so closely interwoven with our whole mechanical and manufacturing progress that only engineers and manufacturers possess the definite knowledge, practical experience, and judgment to forecast the effect of so profound a change.

"The main question to consider is whether with the present advanced development of our industries, we can afford to make a change. If it is the judgment of a majority of those connected with our manufacturing and engineering interests that it would involve so much confusion and loss and would develop such mechanical difficulties as to completely overshadow any possible gain, then their judgment should prevail. When our manufacturers and engineers can see that the proposed change will benefit those who use their products or will increase their sales in countries using the metric system, they will need no urging to adopt it.

"Probably the best service MACHINERY can render its readers at this juncture is to place on record the opinions of some of the leading manufacturers and engineers in the machine-building field. Their opinions are unanimously for the retention of the present system of measurement. They believe that a change would cause great confusion and loss of time and money."

Machine Tool Prices

MANUFACTURERS of machinery of all kinds are interested in the prices of machine tools, not only because they are buyers of such tools, but also because the success of their business depends largely upon the development of the machine tool industry, on account of its basic relation to all other machine building industries.

Some machinery users believe that decreases in the prices of machine tools should parallel price decreases of commodities which have recently suffered marked reductions; but there are some very definite reasons for the maintenance of present quotations which are only too well understood by machine tool manufacturers and which should be understood in the industrial field generally.

No Profit in 1914 Prices

The prevailing machine tool prices are usually compared with those of 1914, and it is true that since then prices have practically doubled; but in most plants wages have been more than doubled, and the increase in the prices of most materials has been even greater. Foundry pig iron that sold for $12.50 a ton in December, 1914, was $42.50 on December 28, 1920, an increase of nearly 250 per cent. Steel bars that sold for 1.07 cents a pound in December, 1914, were quoted at 2.35 cents a pound on December 28, 1920.

Very little figuring is required to show that even without considering the improvements in design and construction during the past six years, the increases in machine tool prices have barely kept pace with the increased cost of labor, and have been less than the proportionate increases in material costs. The decrease in labor efficiency since 1914 has materially increased the unit costs, and with the general tendency toward a decreasing number of working hours the overhead costs have also increased. In 1914, machine tool prices were too low to permanently support the industry. Keen competition due to industrial depression forced manufacturers to accept prices which left them almost no profit, and it was not until 1916 that prices had risen to the level where a working profit appeared.

A well-known manufacturer figures that if 1914 prices had been based on costs with a fair profit, the actual increase in machine tool prices for the following six years would have been only 50 to 60 per cent, or about one-half the labor cost increase and one-third the material cost increase during that period.

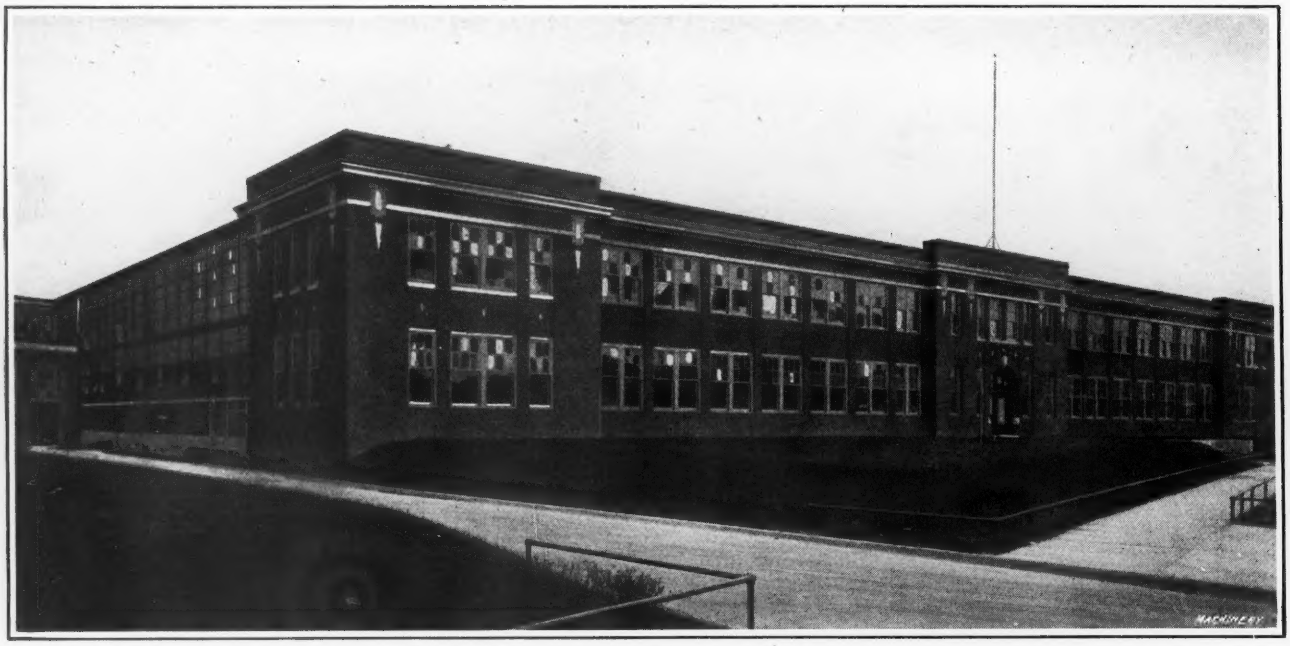
Misleading Price Comparisons

Another erroneous price comparison frequently made is that of the 1914 with the 1921 machine tools, by size or designation. During the war practically all machine tools were improved in design, and better materials were used in their construction. Taking a specific case, a certain machine tool that weighed 15,200 pounds in 1914 was redesigned and now weighs 19,000 pounds; but it is known by the same designation as to size and other characteristics as it was seven years ago. Not only was the weight of this machine increased so as to afford increased strength and steadiness for greater production, but the speed also was increased nearly 100 per cent and the power from 8 to 20 horsepower. These changes necessitated gears made from higher grade material, properly heat-treated, and in one instance a rack was made to replace the type formerly used, the material for which cost three times as much as the other. These and other added costs should be considered when statements are made that a certain type or make of machine tool has been increased in price a given percentage since 1914. In many cases, like the example mentioned, it has also increased in weight, capacity, power and speed, is made from better material, will last longer and produce more. No such statements are correct regarding clothing, shoes, sugar, or other commodities which have greatly declined in price and with which the market position of machine tools is often compared.

Cost of Machine Tool Development Work

Machine tool prices, instead of being high as compared with pre-war prices generally, are low; and if the machine tool industry is to continue as the most important factor in the development of machine building, present prices cannot be reduced. Machine tool manufacturers in the past have turned a great part of their profits back into experiments and developments which insured further progress in the machine building industry. This work must not be curtailed. The remarkable advance that has taken place in the electrical industry during the past fifteen years has been due, primarily, to the fact that manufacturers of electrical appliances have made enough money to permit extensive research and costly experiments, which, in turn, have made possible the building of more efficient electrical apparatus, ultimately reducing the cost of electricity to the user.

The same principle applies to the machine tool industry. The experiments that the manufacturers have made enabled them to develop new methods of machining, which, when used in their customers' shops, have often reduced the cost of the product by almost incredible percentages. No one acquainted with the facts will deny that had it not been for the development work of our machine tool builders, the quantity production methods in the automobile shops would have been impossible, the development of the automobile industry to its present proportions inconceivable, and the advent of the low-priced car improbable. The wonderful showing of our metal manufacturing industries during the war was also due, primarily, to the experiments and efforts of our machine tool manufacturers—and to the development work into which they had turned such a large part of their profits in the past. Our machine tool manufacturers must be allowed a sufficient margin of profit in the future to undertake expensive experiments and development work, to employ designers of the highest ability and skilled workers of the best type. Only under those conditions can the machine tool industry continue to be a training school for the men who will later be the leaders in the whole machine building field.



New Plant of the Foote-Burt Company

Features of a Modern Factory Planned with a View to the Convenient Handling and Progressive Routing of the Work

THE recently completed plant of the Foote-Burt Co., at East 131st St., and St. Clair Ave., Cleveland, Ohio, is typical of the progressive spirit that has made Cleveland the largest machine-tool building center of the Great Lakes region. Approaching the main entrance of this plant, one is impressed with the clean-cut substantial appearance of the building. With a total floor space of 131,000 square feet, it is one of the largest modern plants equipped for the production of drilling machines. The modern idea of constructing along lines which permit the work to pass through the shop with as little unnecessary trucking as possible has been highly developed throughout the plant, as will be evident from a study of the accompanying illustrations.

General Plan of Building

As shown in the plan view, Fig. 6, the width of the building is 236 feet 2 inches, and the extreme length 507 feet 4 inches. The office and drafting-room, each having an area of 5776 square feet, and the factory proper with an area of 117,340 square feet, are all under one roof. The heating plant, coal shed, transformer house, and chip storage building are located just across a spur track of the New York Central Railroad, which extends along a spacious platform at the northeast side of the plant. As indicated on the plan view the general office extends across the front of the building on the ground floor, while the drafting-room is located on the second floor directly over the office, the total height of office and drafting-room being approximately equal to the height of the adjoining assembly department.

It will be noted that there are two main aisles extending the full width of the building. These aisles divide the main factory into three sections, the section farthest from the main entrance being equipped for storage, while the various machining departments are located in the central section. The remaining section nearest the entrance is equipped for assembling. This arrangement permits the rough stock to enter at one end of the plant and advance to the opposite end during the machining operations, until it finally arrives at the

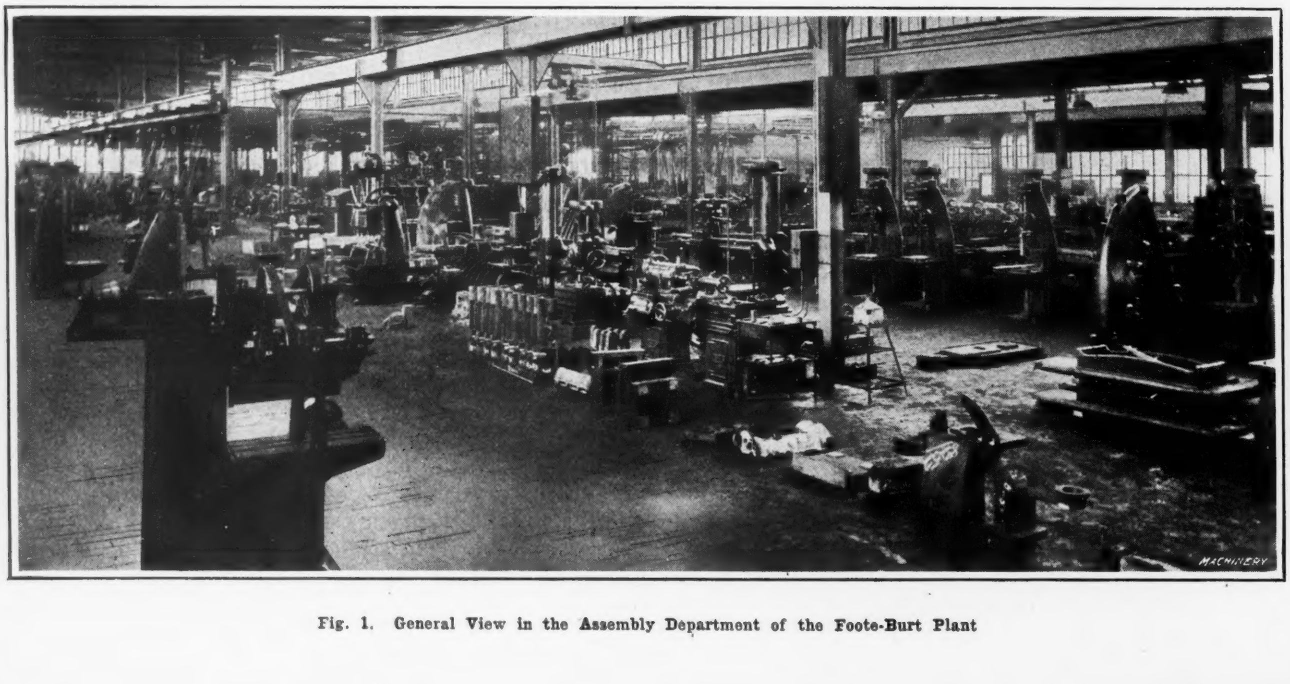


Fig. 1. General View in the Assembly Department of the Foote-Burt Plant

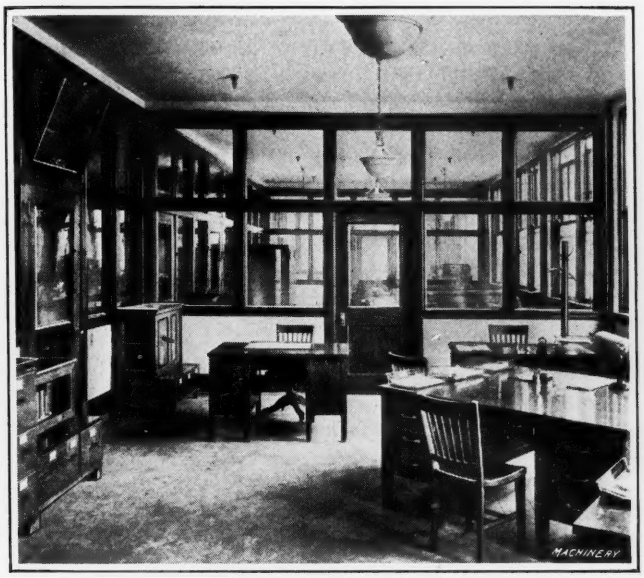


Fig. 2. Interior View of General Office

Fig. 3. Interior View of Drafting-room

assembly department, from which the completed machines are transported to the shipping department.

The General Office

At each side of the main entrance and extending the full width of the building, as previously stated, are located the general offices of the plant. Facing the northwest and provided with specially large windows, these offices obtain excellent natural lighting throughout the day. Referring to Fig. 2, which shows an interior view of one of the offices, one will be impressed not only by the convenient arrangement of files, desks, and other office furniture, but also by the sense of harmony so often lacking in business offices. Next to the superintendent's office, located at the northwest corner of the plant is another entrance by which members of the office or drafting-room may enter at the western side of the plant. Adjoining this entry way, and extending along the western side of the plant, are located the factory office, employment office, dispensary, and experimental department.

The Drafting-room

The drafting-room, being directly over the general office, obtains the same natural lighting advantages as the latter. It is approximately 235 feet long by 24 feet wide, and will accommodate 100 draftsmen. Referring to the interior view, Fig. 3, it will be seen that individual lamps suspended from the ceiling provide general illumination. A study of Fig. 6 will reveal the convenient position of the drafting-room in relation to the departments to which the draftman's work is most likely to take him.

Receiving and Storing Departments

With the preceding brief introduction to the executive and planning departments of the plant in mind, it may perhaps be well to continue our inspection of the factory by beginning at the receiving department. Here we find that all rough stock is received in the rear main aisle, the position of which is shown in Fig. 6. At one side of the aisle, and nearest the door opening to the railway platform, is located the receiving department. Then following in succession are the rough stock storage room, paint shop, machinery storage room, bar stock storage room, patternmaking room, and pattern storage room. With the exception of the paint shop and patternmaking room these departments are provided with 2- or 5-ton overhead cranes. The stock is actually handled in three separate divisions: that handled by the rough stock room just mentioned; that handled by the tool supply and general factory supply room, located next to the tool-room; and that handled by the finished stock-room located centrally in the assembly department.

Manufacturing Departments

The manufacturing or machining departments, as previously mentioned, are centrally located. In Fig. 5 is shown a section of the planing department. This illustration gives an idea of the excellent lighting conditions, the nature of

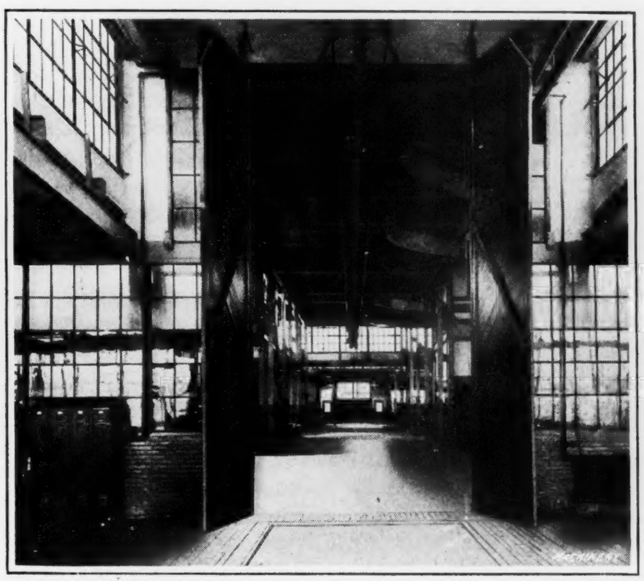


Fig. 4. Front Main Aisle in Manufacturing Section of Foote-Burt Plant

Fig. 5. Section of Planing Department in Foote-Burt Plant

the all-steel construction of the building, and the method of mounting shaft hangers on steel beams, no wood whatever being used. The manufacturing section includes the departments or rooms referred to in the following, which have been carefully located and equipped.

The planer department, occupying two bays, extends the full length of the machining department or from the rear main aisle to the front main aisle. This department is equipped with one 5-ton and one 2-ton overhead crane to provide for handling heavy work such as cast-iron machine bases. Next to the planer department and leading off from the rear main aisle is the drilling department. Beyond the drilling department, but in the same bay, is located the boring mill department. A 2-ton overhead crane is also provided for moving heavy work from the drilling department to the boring mill department or vice versa, as conditions may require. Next to the boring mill department and leading off from the front main aisle is the tool-room and tool supply room.

In the bay adjoining the tool-room and next to the rear main aisle are located the turret lathe department and the polishing department. Next to these departments is the heavy lathe department, which adjoins the grinding department. This enables heavy work such as spindles, machine columns, etc., to be transferred directly to the grinding department after being rough- and finish-turned. At the western side of the machining section and next to the heavy lathe department is located the light lathe department, and between the light lathe department and the front main aisle are located the milling machine department, gear-cutting department, and the inspector's room. At the northwest corner of the machining section is located the hardening room. A door at one end of this room opens into the light lathe department, while a door at the opposite end opens directly into the front main aisle.

Assembly Department

Across the front main aisle from the machining section is located the assembly department, a section of which is shown in Fig. 1. Four 2-ton overhead cranes and two 10-ton overhead cranes are provided for moving the work through this department. From the assembly department the finished machines are transported to the shipping department by means of two 7½-ton monorail cranes. At the entrance to the shipping department and directly under the monorail is a 15-ton scale. The shipping department opens directly on the platform of the spur track.

* * *

COURSE FOR SAFETY SUPERVISORS

The second annual lecture course of the School for Safety Supervisors was started January 10 and will continue until April 4. The course is given for the benefit of managers, engineers, superintendents and safety men, by the Metropolitan Safety Council under the joint auspices of the National Safety Council and the Safety Institute of America. Twelve lectures will be given dealing with safety principles and various phases of safety work, in the Engineering Societies Bldg., 29 W. 39th St., New York City, and similar schools will be conducted in many other industrial centers. All companies who are members of the Metropolitan Safety Council are invited to send their safety supervisors, engineers, inspectors, superintendents, and managers to the school, and other industries in the Metropolitan District interested in accident prevention are also invited to avail themselves of the course. Certificates will be given to persons who attend nine or more of the twelve lectures. Experience has shown that such lecture courses are invaluable to those who have charge of safety in industrial plants. Further information in regard to the course can be obtained from the Safety Institute of America, 261 Madison Ave., at 39th St., New York City.

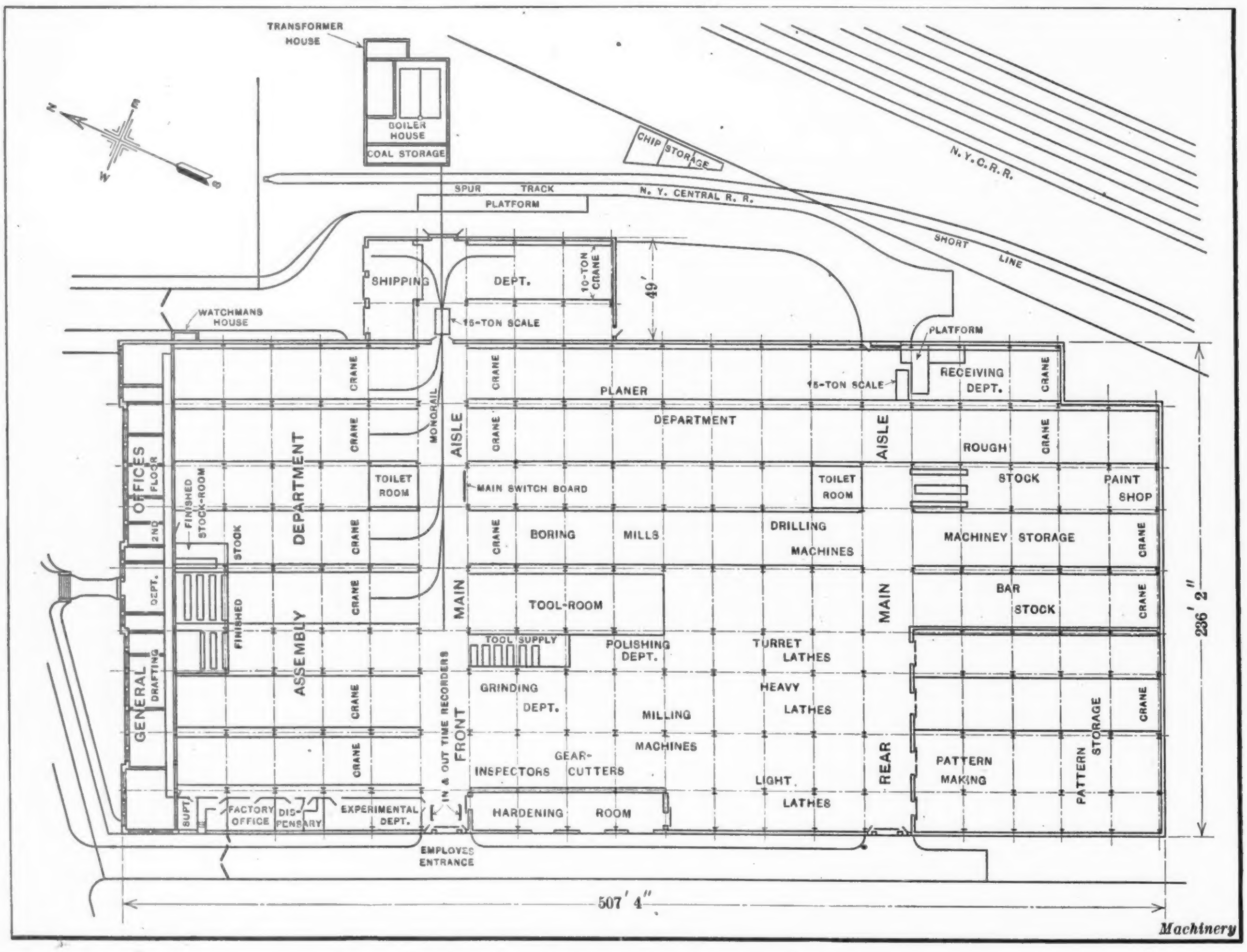


Fig. 6. Plan View of the Foote-Burt Co.'s New Plant in Cleveland, Ohio

NEW ACTIVITIES OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

A number of activities have been planned for the National Machine Tool Builders' Association and are to be undertaken by Ernest F. DuBrul, the recently elected general manager of the association, who started on his active work in this capacity January 1, with headquarters at 817-818 Provident Bank Bldg., Cincinnati, Ohio. The work of the association naturally divides itself into three separate fields, one having to do with technical questions, another with financial and administrative matters, and a third with markets and selling problems. Mr. DuBrul expects to carry on active work along all these lines to such an extent as may be desired by the executive board and the members of the association.

Under the heading "Technical Questions," the most important are those relating to standardization, and it is expected that considerable definite work will be done along this line. There is also a great deal of research work in connection with the machine tool manufacturing industry that might well be conducted by the association instead of being undertaken by individual manufacturers.

Under the heading "Financial and Administrative Questions," which will receive the attention of Mr. DuBrul's office, will come such matters as cost systems, statistics, proper basis for financing machine tool businesses, traffic conditions, credits, legislative questions, taxation, production management, employment management, welfare work, and similar matters.

Ernest F. DuBrul, the New General Manager of the National Machine Tool Builders' Association

The third subdivision to which the association will devote its efforts relates to markets and selling problems, such as development of domestic and foreign markets, cooperation with the dealers' associations, and educational campaigns that will inform the user of machine tools more thoroughly about conditions affecting the machine tool trade and the economical use of machine tools. An important matter in this connection will be to point out that the useful life of a machine tool is determined not by its continued ability merely to remove metal, but by the economical results obtained from its use. Questions of advertising and salesmanship may also be given attention.

One of these activities has already been started, in that district meetings have been held in Chicago, Cleveland, Cincinnati, Worcester, and New York, at which the principles of determining costs in the machine tool industry were discussed. For this purpose, arrangements were made with C. H. Scovell of Scovell, Wellington & Co., New York City, to lead these meetings and explain the principles of proper cost methods to the members and their accounting staff much in the same way as a lecturer would present a thorough discussion on a subject to a post-graduate class. This question is considered especially important at this time in order that members should thoroughly realize the relation of their costs to selling prices.

At the meetings that have been held, Mr. DuBrul has made special reference to the ups and downs in the machine tool business, because the machine tool manufacturer is so far removed from the ultimate consumer. As aptly stated by Mr. DuBrul, "Machine tool builders are making machines for making machines for making articles that are used by the general public." This means that in times of depression there is little or no demand for the machine tool builders' product, because he is not making an article that is consumed from day to day like the manufacturer of hats or shoes. Mr. DuBrul further emphasized the importance of machine tool manufacturers thoroughly realizing at this time the definite relation between the cost of carrying idle plant and the price of the product, and that the machine tool industry must receive sufficient returns to permit it to continue to grow with the growth of the country.

Mr. DuBrul's training and experience make him unusually well qualified to handle the problems that must be dealt with by the National Machine Tool Builders' Association. He is an associate of the American Society of Mechanical Engineers and was for several years commissioner of the National Metal Trades Association.

* * *

WICACO SCREW & MACHINE WORKS OCCUPYING NEW HOME

The increasing business of the Wicaco Screw & Machine Works, Inc., Philadelphia, Pa., so overtaxed the capacity of the building space formerly occupied by it that some time ago it was found desirable to erect an entirely new office and factory building at Stenton Ave. and Louden St. The construction of the new home and the moving from the old has now been completed. The building is modern in every respect; it is made of brick and concrete, of fireproof construction, and is generously provided with windows to furnish adequate light and ventilation. The office portion of the building is three stories high, and has a total floor space of 8000 square feet, while the factory is two stories high and has a floor space of approximately 32,000 square feet.

The entire plant is heated by a hot-water system, and is electrically lighted. All machines and lineshafts are motor-driven, so that an engine and boiler house are not required for generating power. There are about 175 machine tools, including many automatics, screw machines, and turret lathes of modern design. A heat-treating department equipped with a number of gas furnaces and quenching tanks makes possible the hardening and tempering of tools and products. Large fireproof vaults are built for the storage of patterns and to serve as a tool supply room. An improved type of weighing scale has been installed, this scale being provided with an electrical attachment that facilitates the weighing operation. Shower baths and rest rooms are furnished for the comfort of office and factory employes, and there is an athletic association to offer recreation and amusement.

The firm is in a position to manufacture a diversified line of products such as parts machined on screw and grinding machines, gears, jigs, and fixtures, automobile parts, various types of special machinery, etc. It has an engineering department and drawing-room for designing tools and machines. The building occupies only one-third of a two-acre plot of ground, so that the plant can be enlarged as the business develops. As the property is situated along the tracks of a railroad, shipping facilities are excellent. The Wicaco Screw & Machine Works, Inc., was established in 1868 and incorporated in 1915.

* * *

The imports into Japan of machinery of all kinds amount to about $45,000,000 annually, of which the United States in 1919 supplied over $33,000,000 worth, the United Kingdom taking second place with $8,000,000 worth. These figures indicate that during and after the war the United States obtained a firm footing in the Japanese machinery trade which, if cultivated and retained, should become very valuable in our export trade. In 1920 machine tools were exported to Japan to a value of about $1,500,000, and all other metal-working machinery about $1,750,000.

The German Machine Tool Industry

From MACHINERY'S Special Correspondent

Berlin, January 10

A NUMBER of the machine tool builders in Germany have issued their annual reports for the business year 1919-1920, and it is possible from these to obtain an idea of the present status of the German machine tool industry. J. E. Reinecker of Chemnitz paid a dividend of 20 per cent, and the report says that the prospects are favorable for the future, the shops having a sufficent number of orders on hand to keep them busy until the spring of 1921. The past year was a favorable one for the company; large orders were secured from abroad and considerable profits were realized by the firm on the foreign exchange. Apart from the dividends declared, 3,000,000 marks will be used for re-equipping the shops with new machine tools. The company also reports having made arrangements with foreign dealers which will assure the favorable sale of their machines abroad.

Sonderman & Stier, Ltd., of Chemnitz, have increased their capital from 4,000,000 to 10,000,000 marks and acquired the factories of an old textile machine builder in Chemnitz. It is stated that the machine tool business of Sonderman & Stier during the latter months has been good.

The Zimmermannwerke of Chemnitz state that their foreign business during the past fiscal year was good. A dividend of 10 per cent has been paid, as compared with no dividends in the previous year. It is said that the products of the company are in considerable demand.

Schiess Ltd., of Düsseldorf report that their works were fully occupied during the past fiscal year as far as orders were concerned, but strikes and scarcity of coal caused the plant to be shut down for an entire month. A dividend of 8 per cent will be paid, as compared with no dividends during the previous year. The works are fully occupied at the present time, but the decrease in new orders points to lack of full employment during the next few months. The majority of the stock of this company was acquired a few months ago by the iron and steel dealers of Otto Wolf of Cologne, but has since been secured by the Deutsche Maschinenfabrik of Düsseldorf.

The Gildemeister Machine Tool Works of Bielefeld found foreign sales difficult on account of foreign competition, while domestic buyers were reluctant to place orders on account of the general economic conditions of the country. Special types of machine tools built by the firm found a ready sale, but new orders have not been booked to such an extent that continuous full operation of the works could be secured throughout the year.

Apart from the results obtained by some of these larger firms, the machine tool business in general continues to be dull. While some of the larger firms are still busy, by far the greater number of machine tool manufacturers are confronted with great difficulties, as there is hardly any domestic demand for machine tools, and foreign buyers are now inclined to hold off placing orders. There are many foreign inquiries, but they do not lead to much concrete business, and the stocks on hand are constantly increasing.

Prices for Machine Tools

The prices for machine tools have been considerably reduced. As an example, large planers 80 by 32 inches are offered at from 26,000 to 33,000 marks. A few months ago a planer of this size was quoted at from 50,000 to 70,000 marks. Sixteen-inch lathes now are quoted at from 10,000 to 15,000 marks, although lathes of some exceptionally well-known makers of the same size still cost 20,000 marks. Screw machines, 1¼-inch size, cost about 12,000 marks, and vertical turning and boring mills with a 4-foot table, 130,000 marks. The price per pound of the general run of machine tools may be said to average from 6 to 8 marks.

Small Tool Market

The news from the small tool market indicates a decided improvement in sales. Foreign buyers have placed a considerable number of orders, although these orders do not as yet keep the works going to full capacity. American competition is appreciable in the Scandinavian countries, Holland, and Switzerland. The German prices are such as to give German manufacturers a chance to compete, but both French and American competition is said to be keen. No figures are available for exports and imports of machine tools. All such statistical matter is to be worked out at one central office, but this office has not yet begun to supply the information to those interested.

Sales of Machine Tools by the German Government

Considerable discussion has been caused by the reading in the German Reichstag of the Kahn contract for the disposal of machine tools owned by the German Government. Mr. Kahn, a man twenty-nine years of age, with some capital, made a contract last September with the management of the German Works, Ltd., (owned by the German Government) according to which the works would sell to him all machine tools not needed in the works and all special machines for the manufacture of war materials. Approximately 47,000 tons of machine tools were involved, the idea being that these machines should either be sold as scrap or as second-hand tools. Mr. Kahn paid 1050 marks per ton for the machines as scrap; but the scrap value rose from 1500 to 1700 marks per ton, and he made millions of profit from the transaction. Inasmuch as the government works might as well have sold the scrap iron directly at the current market price, the contract has been severely criticized.

Mr. Kahn was also given right in the contract to obtain the machines at any time stipulated by him, so that he could take them when the prices of scrap iron rose, and could leave them at the works when the prices fell. He obtained still greater profits by reselling some of the machine tools and not scrapping them at all. It has been mentioned that 10,000 tons of machine tools thus disposed of at a price far below the market, would still net him over 30,000,000 marks. The contract runs until 1923, and in accordance with it Mr. Kahn has a monopoly on the selling as scrap or second-hand of all the machines to be disposed of by the German Works, Ltd. The contract was made without the knowledge of the German administration and of the minister of finance. In November the whole board of directors of the works were therefore forced to resign.

The Ford Co. in Germany

A great deal has been published about the Ford Co. entering the German industrial field. At first it was said that Mr. Ford intended to manufacture automobiles in Germany, but this has been officially denied. It is understood that the Ford Co. intends to manufacture the Fordson tractors in Germany and will erect a plant for an output of 100 tractors a day, working in cooperation with the important Berlin

firm of Ehrich & Graetz. The idea is that the German Ford Co. will not only supply Germany but also other European countries with tractors from this factory. The tractors will cost about 20,000 marks, and this price, it is believed, will make them available even to the smaller farms.

The Siemens, Rhein-Elbe Union, Schuckert

The largest and most important industrial combination in 1920 is that of the coal, iron, and manufacturing industries represented by what is known as the Siemens, Rhein-Elbe Union, Schuckert. This combination includes two of the greatest German mining concerns—the Gelsenkirchener Bergwerksgesellschaft, owner of the richest coal mines of Germany, and Deutsch Luxemburg, owner of the largest iron mines; it further includes the important iron works of the Bochumer Verein, into which finally the Siemens-Schuckert works have entered, this latter being one of the largest of the German manufacturing concerns. The new combination occupies both in size and in wealth of natural and economic resources, in manufacturing experience, and in foreign selling organizations, the most prominent place of any industrial combination in Germany. Through the formation of this combination, 2,500,000,000 marks have been tied together in one concern.

The reason for this great combination is doubtless the economic position of the German industries. The situation is such that those concerns that do not control raw materials face a more and more difficult position, and the present combination now controls the entire industrial process from the coal and iron in its raw state to the finished machinery ready for domestic sale or export. It also makes it unnecessary to bring in a great deal of new capital and to keep large quantities of materials in stock in order to prevent a shortage. Another factor that has been considered in creating the present combination is that on account of the relatively small quantities of raw materials left at the disposal of the German industries, it is necessary that they be utilized in the most efficient and economical manner, and that any raw materials imported from abroad be finished into the highest types of machinery and devices. As somebody has said, "The German industry must be a finishing industry, and the future of the country must be based upon the manufacture and export of watch springs rather than of steel beams."

The Siemens, Rhein-Elbe Union, Schuckert combination represents a new step in industrial combinations in that it is not a combination of similar industries, but one of industries that handle the material from its original state in nature until its final disposition to the ultimate consumer. The aim of the combination is to cheapen the products by complete control of all processes from the beginning to the end. It is possible that this combination will prove the keynote of the new economical development of Germany. The individual enterprises entering into the combination will continue to work in an entirely self-contained manner, but will have the cooperation of all the other members, and all the financial problems will be handled at one central point.

* * *

NEW OFFICERS OF THE AMERICAN SOCIETY OF MECHANICAL INSPECTORS

The American Society of Mechanical Inspectors, 57-59 W. 51st St., New York City, announces the election of the following officers for the coming year: President, Walter Thoma, chief inspector of the E. W. Bliss Co.'s plants; vice-presidents: Joseph Zeigner, chief inspector of the Doehler Die-Casting Co.; John E. Fitz Simons, chief inspector of the Pyrene Mfg. Co.; J. W. Gardham, chief inspector of the Maxwell Motor Co.; Alfred Hanson, gage engineer; George Allison, engineer of the Mergenthaler Linotype Co.; and Joseph Ludwig, assistant chief inspector of the E. W. Bliss Co.; treasurer, William Oulsnam; assistant financial treasurer, Carl Engstrom; and secretary, H. F. Winter.

ANNUAL MEETING OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

The sixteenth annual meeting of the Society of Automotive Engineers was held in New York City, January 11 to 13, in the Engineering Societies' Building, 29 W. 39th St., New York City. The first technical session was devoted to aeronautic engineering. C. D. Hanscom outlined the development of wing sections during the past year, and Grover C. Loening presented a paper on the trend of structural design. Major Thurman H. Bane told of the recent work of the Air Service at McCook Field, his talk being illustrated with motion pictures. F. W. Caldwell covered the advances in propellers since the armistice.

The annual business meeting of the society was held Wednesday morning, January 12, at which the reports of the administrative committees were read and officers for 1921 elected. Three simultaneous technical sessions were held Wednesday afternoon, covering chassis design for fuel economy, body engineering, and commercial aviation. In the Chassis Session, A. L. Putnam outlined the many power losses, independent of the engine, which reduce fuel efficiency and deserve closer study; this subject was also discussed by J. G. Vincent. D. McCall White presented a paper on modern chassis construction. A. L. Nelson offered a paper on the fuel problem in relation to engineering. C. W. Spicer presented a brief contribution on the torsional strength of splined shafts, and a new principle of engine suspension was submitted by S. E. Slocum. H. M. Crane, who presided at the Chassis Session, proposed a method of rating racing cars that will encourage passenger car development.

In the Body Engineering Session, Charles A. Heergeist presented a statement on the reduction of body weight, and Andrew F. Johnson made some general remarks. George J. Mercer dealt with the subject of body lines and predicted the styles for 1921. George E. Goddard illustrated the steps in quantity production of all-metal bodies with some interesting motion pictures, and Kingston Forbes discussed the relation of the body engineer to the industry.

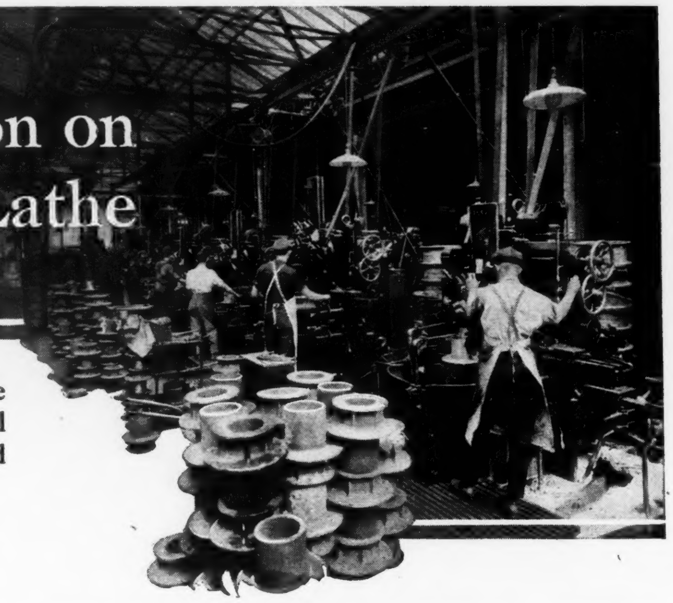
The Aeronautic Session, held Wednesday afternoon, was devoted to commercial aviation. Glenn L. Martin addressed the members on this subject, and Ralph H. Upson read a comprehensive paper on the application of aircraft to the transportation of the immediate future. The development of commercial air transport lines in Europe since the war was described by Professor Edward P. Warner, of the National Advisory Committee for Aeronautics, who recently returned from abroad.

At the Fuel Session, on Thursday morning, January 13, C. F. Kettering told of the results of fuel research work carried out under his direction. This session was continued in the afternoon simultaneously with the Highway Session. Dr. H. C. Dickinson presented some experimental studies made by the Bureau of Standards, and R. E. Fielder described a system of thermostatic inlet temperature control as installed on the Fifth Ave. busses in New York City. F. A. Howard, of the technical staff of the Standard Oil Co., discussed the volatility of motor gasoline. P. S. Tice presented some conclusions reached as a result of inlet manifold flow study, and A. W. Scarratt described recent tests on alcohol as an engine fuel.

H. W. Alden, in opening the Highway Session on Thursday afternoon, emphasized the responsibility of the automotive engineer in the making and maintaining of good roads. The Bureau of Public Roads has conducted an extensive practical study of highway design during the past year, and A. T. Goldbeck presented the data and conclusions. H. E. Breed, formerly deputy state highway commissioner of New York, presented a paper entitled "Variable Factors that Influence Highway Design," and W. E. Williams offered some additional suggestions.

The entertainment features of the meeting included a carnival and a dinner at the Hotel Astor.

Obtaining Production on the Vertical Turret Lathe



Application of the Bullard Vertical Turret Lathe to Machine Shop Practice, Including Typical Examples and a Description of the Tooling Used

WHEN machining certain types of work a number of advantages are gained by chucking the parts in a vertical position. They may be held rigidly and in such a manner as to allow heavy cuts to be taken without danger of the work being machined inaccurately or the setting destroyed. With the piece thus secured, an opportunity is offered for presenting the greatest number of tools to the work; this, however, is usually a matter of design of the machine. This article does not deal with the design of any particular machine, but rather with the method of performing machining operations on a vertical turret lathe. For the purpose of bringing out the various characteristics of a machine of the vertical type, the Bullard vertical turret lathe has been selected as a means of illustrating this type of work. In this machine, which is built by the Bullard Machine Tool Co., Bridgeport, Conn., the use of an auxiliary square turret or side-head, is the special means by which increased tool availability is realized. Among the advantages gained from vertical chucking, the possibility of increased swing is, perhaps, as important as any that might be mentioned. This fact rather classifies the vertical turret lathe as a producer of large work rather than of parts usually thought of as the product of a turret lathe or hand screw machine. For that reason, a following article will deal exclusively with locomotive machine shop work, in which this machine is found to be especially suitable.

In selecting examples for the purpose of illustrating the machining operations, it has been the intention to describe operations which will involve not only regular practice, but the use of special attachments such as the crowning attachment, thread-cutting attachment, and special turning tools. The tools can be readily presented to the work, so that, in general, the use of special tool-heads and similar equipment is not required. Unless it is for the purpose of materially increasing production, a large percentage of all typical vertical turret lathe work machined on the lathe here mentioned can be handled without the use of special tools.

Tooling Possibilities of the Vertical Machine

The tooling of a vertical turret lathe presents an opportunity for much variety in arranging the tools and sequence of operations. For example, in producing piston-rings from pot castings, it has been found that using a multiple parting tool in the side-head turret is one method of obtaining high

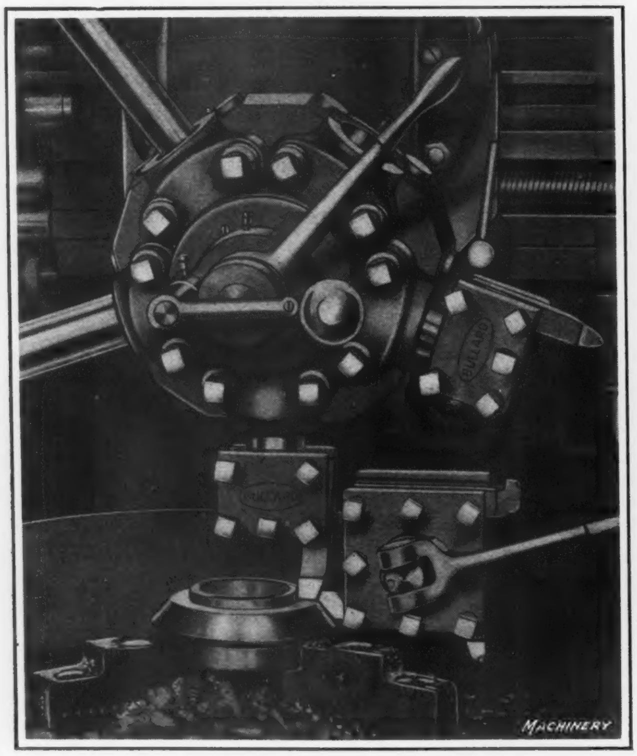


Fig. 1. Tools carried in the Main and Side-head Turrets used in Unison as a Forming Tool

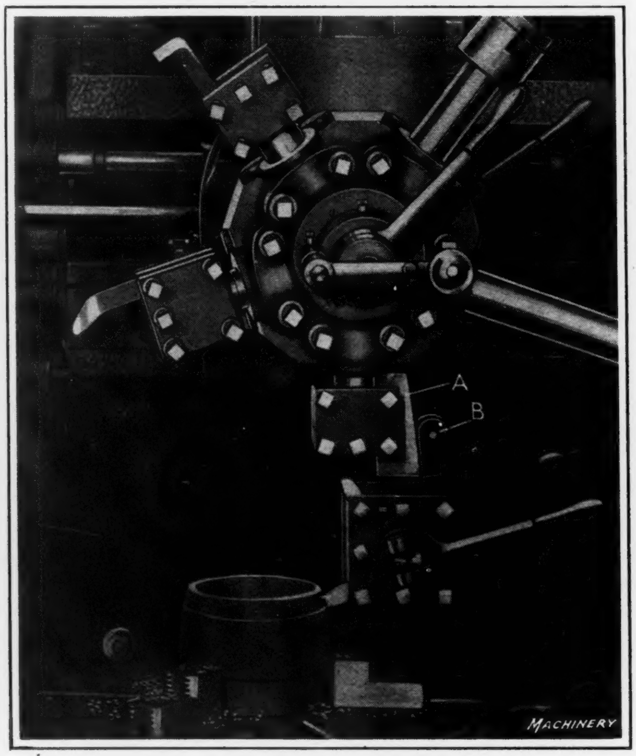


Fig. 2. Method of machining a Taper Surface by using a Special Taper Cam in the Main Turret

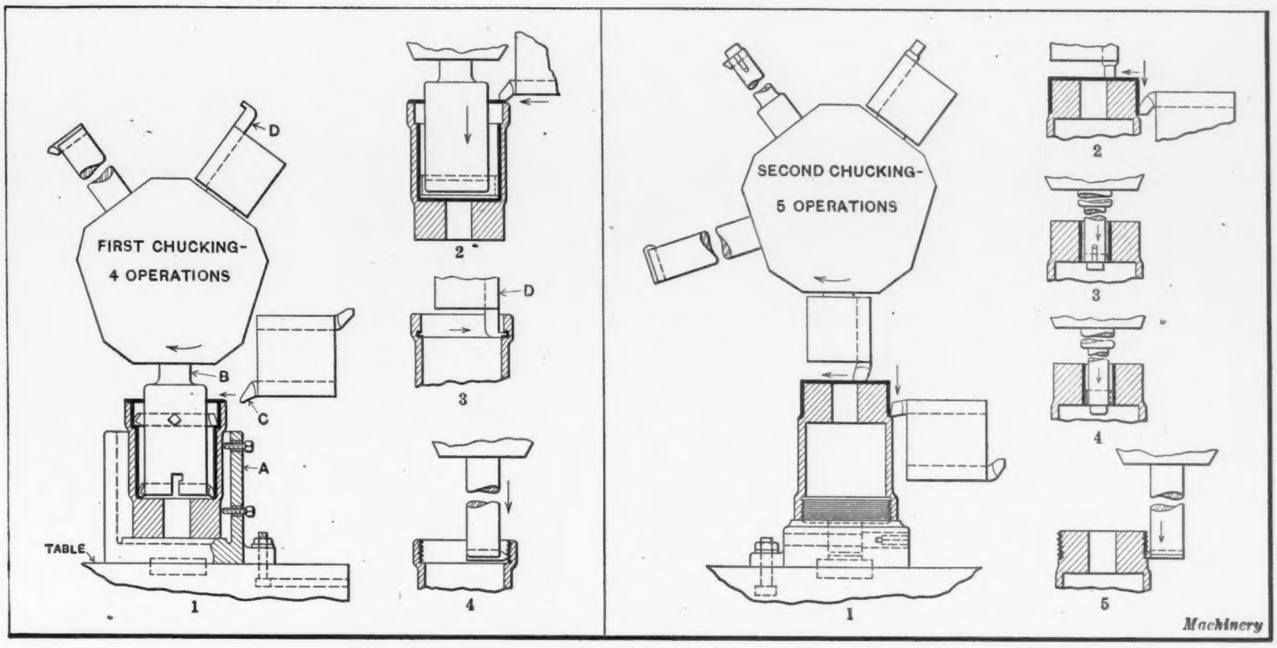


Fig. 3. Tooling Lay-outs for machining a Turbine Section in Two Chuckings

production, whereas the same job is successfully performed in certain shops by using a hook-shaped parting tool in the main turret and a single or double parting tool in the side-head turret, both working simultaneously. These things are, of course, determined by such factors as the number of operations necessary to finish the work, the possibility of varying their sequence to obtain a desired tool lay-out, and various other local considerations.

The simultaneous use of both turrets is well illustrated in Fig. 1, showing how two tools may be used where a special formed cutter might otherwise be required. The bevel-gear blank selected to bring out this tooling also illustrates the possibility of bringing the two tool-heads very close together. Fig. 2 shows how a tapered surface may be machined without the use of the regular compound feeds or forming attachment, by using both tool-holders. It will be seen that a steel block *A* has been secured in the main turret tool-holder, which acts as a cam against which a roller operates to guide the turning tool in the side-head turret. This roller is carried in arm *B* which occupies the place of a regular tool in the side-head turret. This is a simple and effective method of obtaining the desired results.

In the line illustrations showing the tooling lay-outs, the surfaces to be machined are indicated by heavy lines; also the direction of rotation of the turret and the direction of travel of the tools are indicated by arrows, so that the machining operations may be conveniently followed.

Thread-cutting Operations on a Vertical Turret Lathe

The tooling lay-out shown in Fig. 3 is for a turbine section, and is of interest because a special pot fixture is used to chuck the work, and the thread-cutting attachment is employed in machining the part. The part is made of cast iron and is machined in two chuckings, the first of which requires four operations, and the second, five. In the first chucking, after the work has been secured in the fixture *A*, a special boring-bar *B* is employed to rough-bore the two interior cylindrical surfaces of the casting. At the same time that this

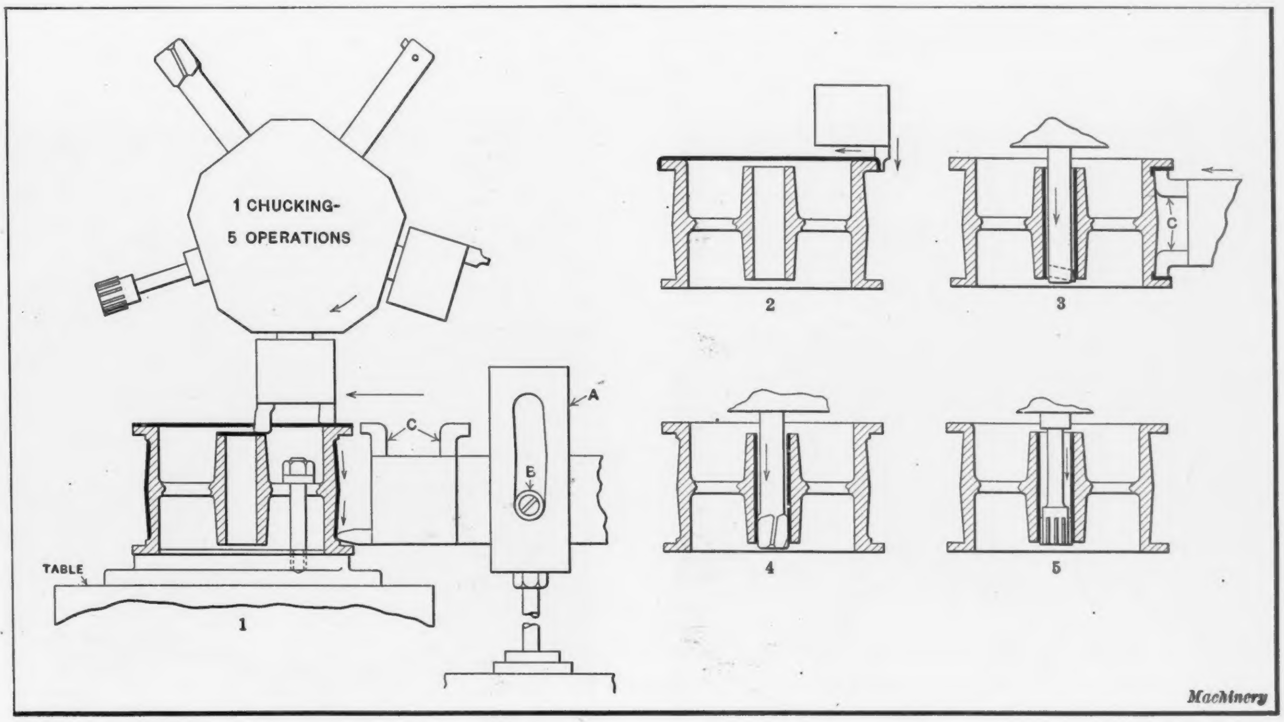


Fig. 4. Sequence of Operations and Tooling Arrangement for finishing a Small Flanged Pulley

bar is in operation, the end of the casting is rough-faced with tool *C* carried in the side-head turret. In the second operation, this surface is finished with a second side-head turret tool, while the smaller bore is being finished. This finishing operation employs the same special bar used in the first operation, with a finishing cutter substituted for the lower roughing cutter. In the third operation, tool *D* cuts the thread-clearance recess; while in the fourth operation, the thread is cut with the threading bit carried in the boring-bar. During the thread-cutting operation, it is, of course, necessary to employ the regular thread-cutting attachment.

The second chucking includes: (1) rough-facing and rough-turning the opposite end of the casting; (2) finish-facing and finish-turning; (3) rough-boring the central hole; (4) finish-boring the central hole; (5) cutting the exterior thread with a single-point tool, again using the thread-cutting attachment. In this chucking another special fixture is used which takes advantage of the previously threaded hole to clamp the work in place. The time required to machine this turbine section, including both chuckings, is one hour and fifteen minutes. While the detail of the part is not shown, its general shape may be clearly seen in the illustration. The casting is approximately 7 inches in diameter and 10 inches long.

The more common method of cutting threads is by the use of a collapsible tap or a threading die of the self-opening type. This method, of course, assures a faster production than the method of first chasing them. However, in some instances it is necessary in cutting threads of large pitch to use the thread-cutting attachment first, removing the greater part of the stock in order to preserve the cutting qualities of the tap or die.

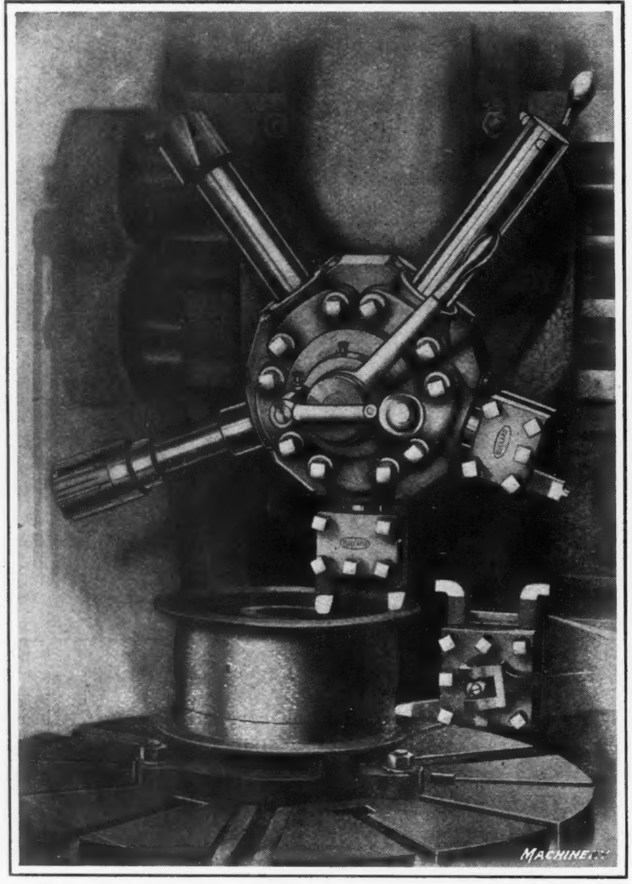


Fig. 5. Crowning a Pulley, the Tooling Lay-out for which is shown in Fig. 4

Crowning Operations on a Vertical Turret Lathe

The operation sheet for the woodworking machine pulley, Fig. 4, shows the tooling lay-out for the five operations in which the pulley is finished. The work is clamped by means of the pulley arms instead of securing it centrally, so that all five operations may be performed without relocating the work. In the first operation two tools are used in the main turret tool-holder, to face the end of the hub and of the pulley rim. While these tools are at work the pulley is being crowned by the round-point tool shown in the side-head turret, the feed being in the direction indicated by the arrows. This crowning attachment substitutes a cam-plate *A* having a suitable slot for the regular turret cross-feed gear, so that the guidance of the tool may depend entirely upon the curvature of the slot in this plate in which the guide post *B* operates. The second operation is rounding the pulley flange with the main turret forming tool shown, and the third operation consists of boring the central hole while the side-head turret with its straddle-tools *C* is squaring up the inner sides of the flanges. The fourth and fifth operations consist of rough- and finish-reaming the central hole. The time required to produce this pulley, which is approximately 14 inches in diameter, is twenty-four minutes, including chucking work.

The machining of crowned pulleys is one of the most common operations performed on a turret lathe. Fig. 5 shows the set-up for machining the flanged pulley, the lay-out for which is shown in Fig. 4, but this illustration does not show the crowning attachment for the side-head turret. This

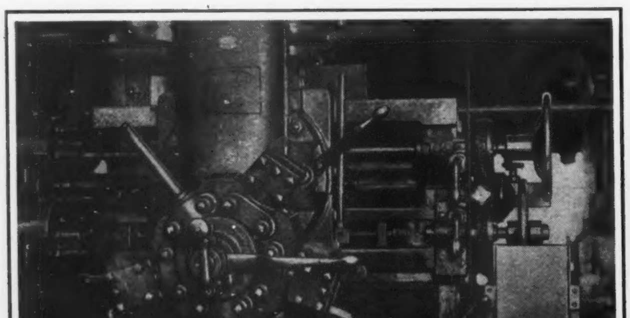


Fig. 6. Operation of Rough-crowning and Rough-facing Driving Pulley shown in Fig. 8

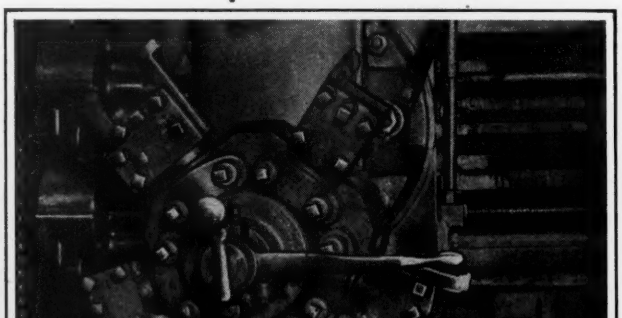


Fig. 7. Finish-boring the Hole and finish-crowning the Face of the Driving Pulley

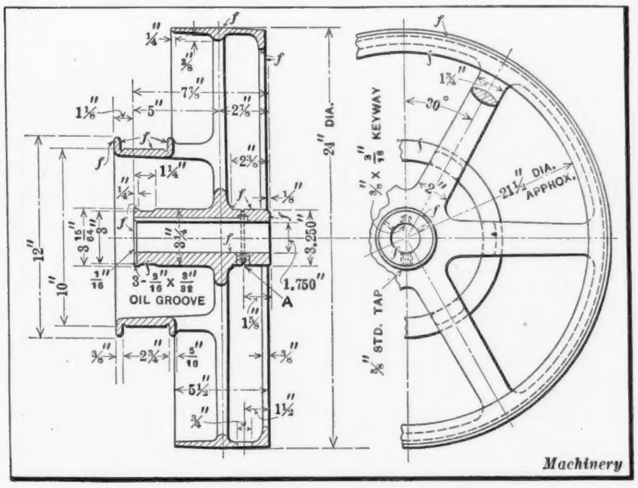


Fig. 8. Detailed Drawing of the Driving Pulley shown being machined in Figs. 6 and 7

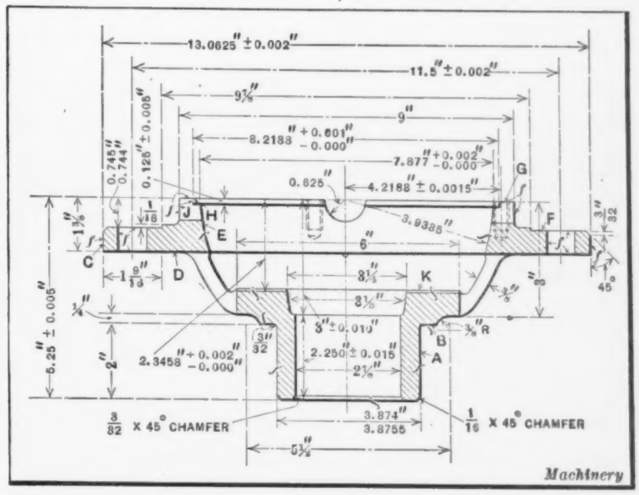


Fig. 9. Detailed Drawing of the Female Half of a Differential-gear Case

crowning attachment may be clearly seen, however, by referring to Fig. 6, in which another crowning operation is illustrated.

The cast-iron driving pulley shown in Fig. 8 is machined on one side with the set-ups illustrated in Figs. 6 and 7, which show, respectively, the rough- and the finish-crowning operations. The tooling lay-out, Fig. 10, shows the operations at the first chucking only. It will be seen that the design of the pulley is such as to make it a simple matter to secure it to the table of the machine. The work is clamped to the table by means of a small flange, and is secured centrally by jaws *A* which operate in radial slots in the machine table, engaging the inside wall of the pulley proper. It is not always that the chucking problem can be so readily handled, as will be seen in some of the examples to follow.

The first operation is that of facing the rim and the end of the pulley hub, the tool being fed clear to the center of the pulley, after being elevated to the proper plane for facing the end of the hub. At the same time that this facing operation is being performed the pulley is being rough-crowned by the tool carried in the side-head turret. This is the operation illustrated in Fig. 6, in which the crowning is shown partially completed. The second operation employs two tools in the main turret tool-holder for turning the hub and squaring up the inner surface of the pulley rim. In the third operation, three tools are used; tool *B* cuts the retainer groove shown at *A*, Fig. 8; *C* squares up the hub with the central web; and *D* rounds the end of the hub. The working position of tool *C* is indicated by dotted lines. In the fourth operation, the end of the hub and rim surfaces of the pulley are finish-faced, and in the fifth operation the central hole is rough-bored. The sixth operation is that shown in Fig. 7, and consists of finish-boring the shaft hole and finish-crowning the outside of the pulley. The time required to perform this series of operations is one hour and thirty-six minutes.

Machining Spherical and Irregular Surfaces

The plate or former employed in connection with the crowning mechanism suggests the use of a similar former for machining surfaces of special contour, after the principle utilized in profiling machines. A good example involving this principle is found in the case of tire-molds and tire-mold cores. The curved surfaces on each of these parts are machined by using a suitable cam-plate for guiding the tool in the roughing operation and a special formed tool for finishing, the tools for both operations being held in the side-head turret. Almost any surface of this nature can be machined by this means, including internal spherical surfaces. In such cases, however, a special tool is required to reach the surfaces that are to be machined.

An example in which interior spherical surfaces are machined is the female member of a differential-gear case, shown in Fig. 9. This gear-case is made of malleable iron, and is machined in the manner indicated by the tooling lay-outs shown in Figs. 11 and 12. In both chuckings, three special jaws are used to hold the work. In the first chucking, first operation, surfaces *A* and *B* Fig. 9, are roughed with the side-head turret tool, shown at work in the tooling lay-out, Fig. 11, while the central hole is being rough-bored with the tool carried in a combination boring- and reaming-bar. In the second operation these surfaces are finished by revolving the square turret to the next tool, and the hole is trued up by replacing the roughing cutter in the cutter-bar with a truing cutter. The third operation is that of finish-

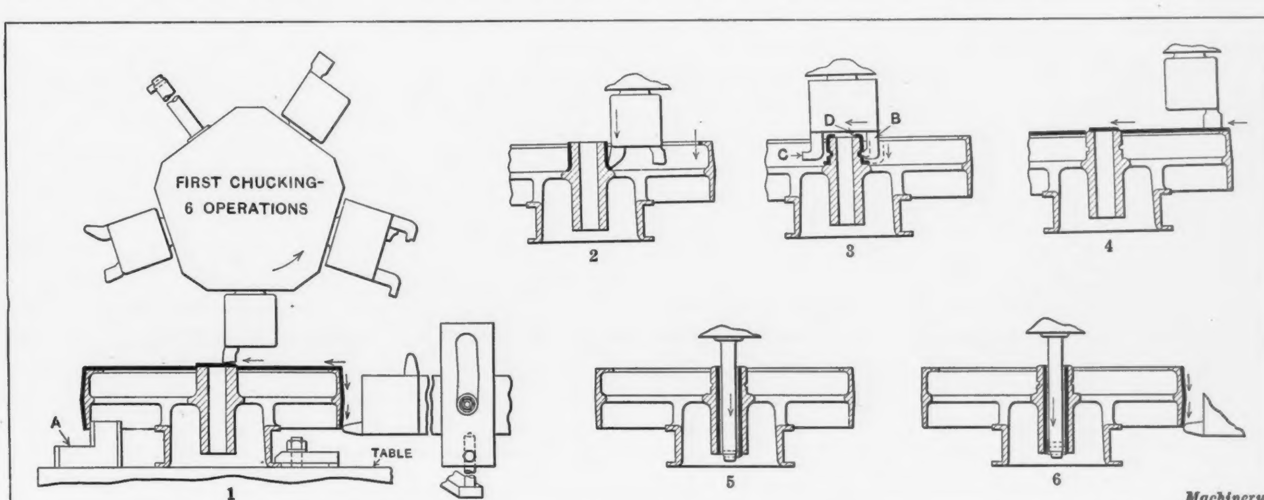


Fig. 10. Tooling Lay-out, showing the Operations Necessary to machine One Side of the Pulley shown in Fig. 8

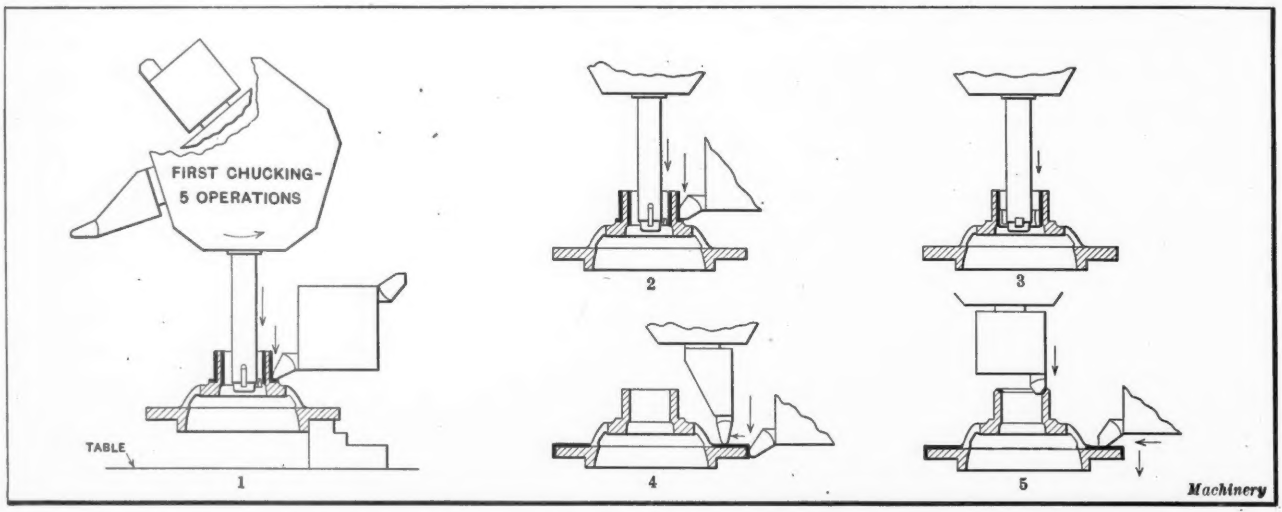


Fig. 11. Lay-out of Operations and Tooling used in First Chucking for machining Differential-gear Case shown in Fig. 9

reaming the hole, while in the fourth operation surface *C*, Fig. 9, is rough-turned at the same time that surface *D* is rough-faced, one tool being carried in the side-head turret and one in the main turret. In the last operation of the first chucking, surfaces *C* and *D* of the casting are finished with a side-head turret tool during the time that the 45-degree chamfer on the hole is machined with a tool carried in the main turret.

In the second chucking, Fig. 12, there are seven operations. After the work has been inverted and relocated on the machine table, the surfaces *F*, *G*, and *K* are rough-machined in the manner indicated in the first operation of the lay-out. This operation, it will be seen, is an excellent example of multiple tooling. The recess *H* is machined with a tool carried in the second station of the main turret, while surface *J* is being rough-turned and surface *F* finish-faced by tool *A*, Fig. 12. In the third operation, surfaces *G* and *K*, Fig. 9, are finished, and in the fourth operation use is made of a special hook roughing tool in connection with a special former plate, such as has already been referred to, for machining the interior spherical surface *E*. Practically the same mechanical principle is involved in this operation as in the crowning operation. For finishing this spherical surface, however, a special turning head is used, as indicated in the fifth operation. The operation of this turning head is governed by its connection with the side-head turret. There is a finger *B*, Fig. 12, held in the side-head turret, and by using a pull-pin, this finger may be connected to link *C* of the turning head. By this means the turning head may be disconnected as soon as the operation is completed, so that it may be swung out of the way. The sixth and seventh operations are those of reboring and reaming the central hole, using cutters in the combination boring- and reaming-bar *D*. The production time for the first chucking is eleven minutes, and for the second chucking, seven minutes.

A detailed view of the special tool-head used in finish-turning the interior spherical surface of the gear-case is shown in Fig. 13. The feed of the side-head turret is upward, as indicated by the arrow, and this results in rocking the two tools which are hung from center *A*, thus producing the desired curvature as the tools pass over these surfaces while the work revolves. It will be noticed that the tools are so mounted in the arm in which they are carried that suitable adjustments may be made for increasing the radial distance of the tools from the pivotal center. The application of this device is clearly shown in Fig. 14.

Machining a Pump Part having a Central Threaded Hole

It has been mentioned previously that where work is to be machined by threading or tapping, the most common practice is to employ a collapsible tap or self-opening die-head. In the example presented in Fig. 16, a pump part known as a lifter is shown, and in Fig. 17 are illustrated the tooling lay-outs employed in performing the machining operations on this part. The central hole in this casting is tapped by using a regular straight-shank tap with the shank reduced

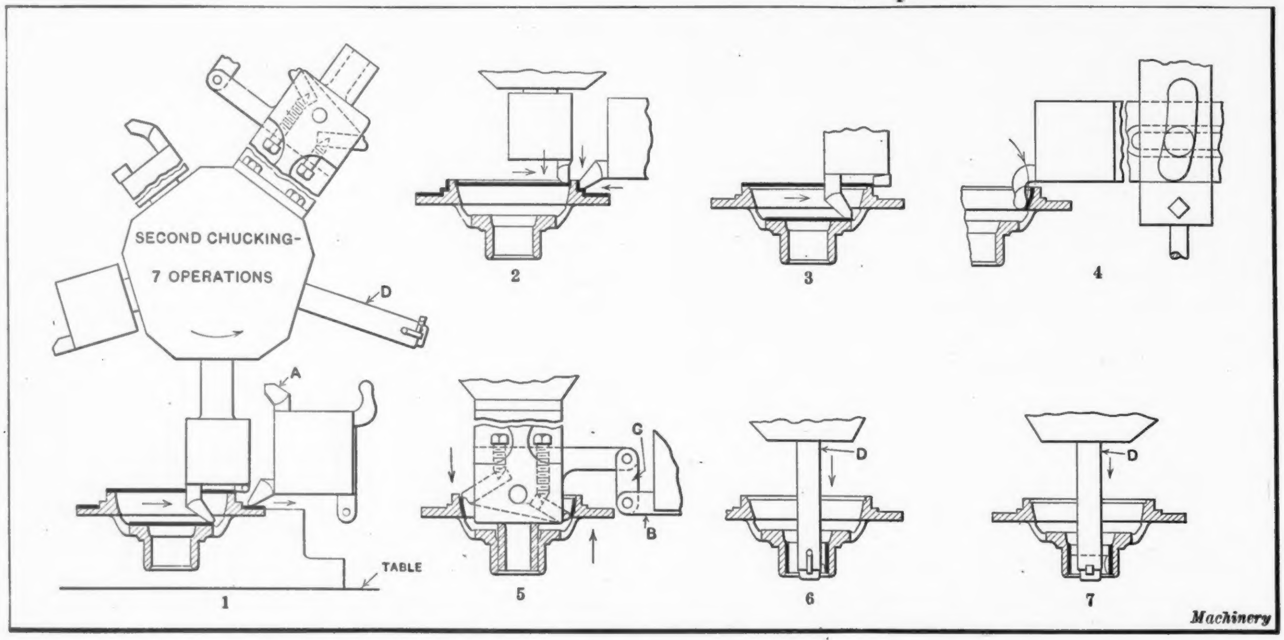


Fig. 12. Lay-out of Operations and Tooling used in Second Chucking for machining Differential-gear Case

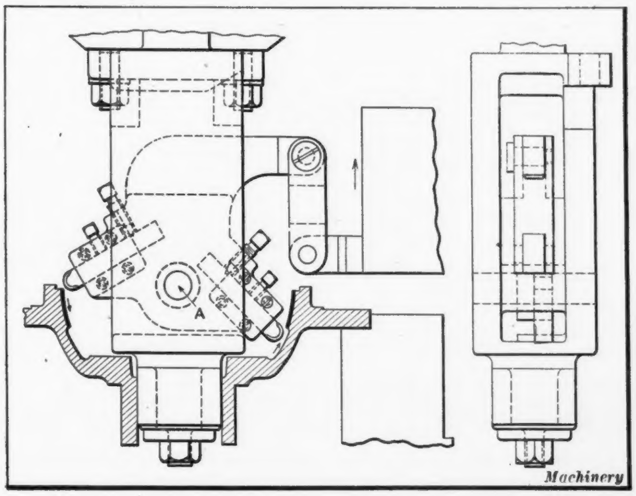


Fig. 13. Spherical Turning Tool-head used in machining Interior Surfaces of Gear-case shown in Fig. 9

in diameter, so that it may drop through the work at the completion of the operation. There are five operations in the first chucking, and these are plainly indicated in the illustration. The work is secured to the table of the machine by three special jaws. During the first operation, the upper part is rough-turned by using a tool in the side-head turret while a special forming tool is being employed in the main turret to produce the bevel at *A*, Fig. 16, and to rough-face surface *B*. The special boring-bar *A*, Fig. 17, is next used successively in the second and third operations for roughing and truing the central hole. The fourth operation is that

Fig. 14. Special Tool-head shown in Fig. 13, in Operation turning Spherical Surfaces of Gear-case

of finishing the surfaces machined in the first operation, and the tools employed are mounted similarly to those previously used for these surfaces. The final operation in this chucking is that of tapping the hole.

The second chucking employs a special fixture which makes use of a central threaded plug for the previously tapped hole, to locate and secure the work to the machine table. It is first rough-turned on the outside—simultaneously with the rough-boring of surface *C*, Fig. 16. The two tools, as in the majority of vertical turret lathe work, are carried, one each, in the main turret and the side-head turret. The second operation is that of finish-turning and finish-boring these surfaces, and the third operation produces the bevel at the upper end of the casting. On this job, a cutting speed of 45 surface feet per minute is employed, and the production time from floor to floor is from thirty-five to forty minutes per casting.

Machining Flanged Pipe Fittings, Valve Bodies, and Similar Work

In most cases the design of flanged pipe fittings, valve bodies, and other parts of this general class, is of a type that requires some special holding device, and for that reason would be of interest principally for bringing out methods of

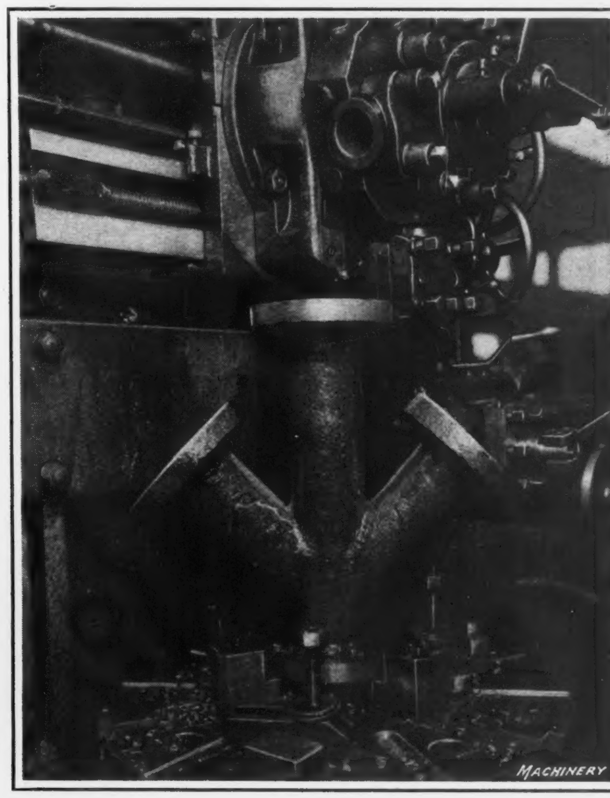


Fig. 15. Three-way Pipe Fitting, 18½ Inches High, which shows the Range of the Machine for High Work

holding. In the machining operations on locomotive parts, which will be dealt with in a subsequent article attention will be paid to special means of holding, so that it is not necessary to emphasize this in connection with other types of work. It is evident that where a piece is of a specially irregular shape, the principal problem in machining it is to provide a rigid means of support. Of course, the shape of the work must be carefully considered, in order to permit sufficient swing. In this connection, attention is to be directed only to one such instance—that shown in Fig. 15. This is a three-way pipe fitting known as a double Y-branch, which stands 18½ inches high. The part was successfully

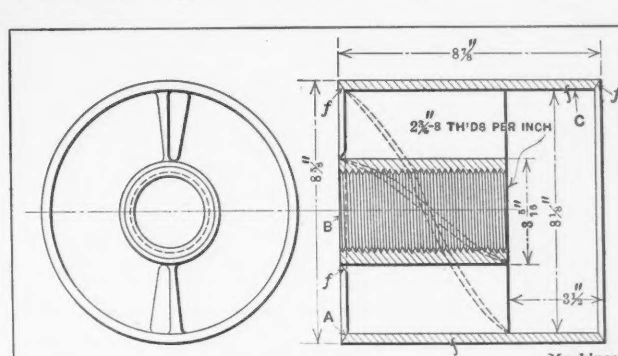


Fig. 16. Detailed View of a Pump Lifter, the Tooling Lay-out for which is shown in Fig. 17

chucked and machined as shown, but it was necessary, owing to the excessive height in proportion to the diameter of the work, to employ the low table speed of 22 revolutions per minute, the feed used being 0.027 inch per revolution of the table.

The locomotive valve body, shown in section in the tooling lay-out, Fig. 18, presents certain points of interest in its machining, due principally to its irregular shape. This part is machined in two chuckings. The lay-out of the first chucking illustrates the method of securing the valve body in a special holding fixture, from which it will be seen that two special straps *A* are used to hold the part down and prevent it from lifting. These straps are so shaped that they enter openings on opposite sides of the valve body, and engage an inner wall of the part, against which they are securely clamped by machine screws. These straps can be adjusted radially by means of safety set-screws *B*. The design of the valve body is such that screws may be employed to engage lugs on the inside of the work, thus forming adjustable stops against which the straps *A* clamp the work.

The holding fixture required for the second chucking is of much simpler construction than that used in the first chucking, since the design of the upper end of the valve provides a suitable locating surface for the work. This may be readily seen by inspecting the set-up for the second chucking. In the first chucking, the stem end of the valve body is faced with a tool in the main turret, while a tool in the side-head turret is being fed down to rough-turn the large diameter. This same tool is also used in the second operation, during which the outside diameter of the lower part of the work is rough-turned, while a tool carried in the combination boring- and reaming-bar *C* rough-bores and finishes the small hole at the upper end of the stem. During this operation it is necessary to remove tool *D* from the side-head turret, because of its overhang and the design of the work. The third operation employs tool *D* to rough-face surface *E* and rough-turn the adjacent shoulder. While this operation is in process, use is made of a special centering pilot *F* carried in the main turret, which enters the previously finished hole in the stem, and acts as a center to prevent inaccuracies in this and subsequent operations on this end of the valve body. In the fourth operation, a special forming tool finish-faces the large diameter at both the top and bottom of the work, and also produces the bevel shown at the lower part of the work, indicated by the position of the tool, which is shown in dotted lines in its second position. In the final machining of the part, before it is reversed, a side-head turret tool finish-faces surface *E* and the adjacent shoulder, and in both this and the preceding operation the centering pilot *F* remains in the work.

There are two operations in the second chucking, consisting of rough-facing and boring the surfaces indicated in the first operation, and finishing these surfaces. These locomotive valve bodies, when made of steel, are machined complete in thirty-five to forty minutes, and when made from a copper-zinc composition, in fifty-five to sixty minutes.

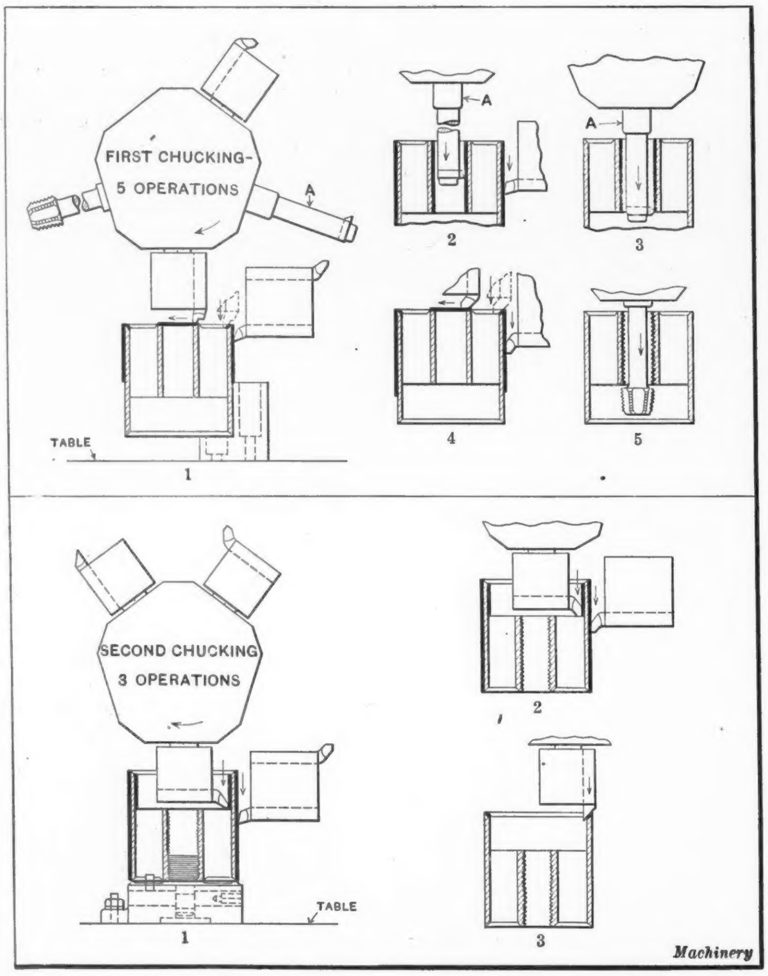


Fig. 17. Tooling Lay-out for Pump Part shown in Fig. 16, illustrating One Method of machining Work that requires a Tapping Operation

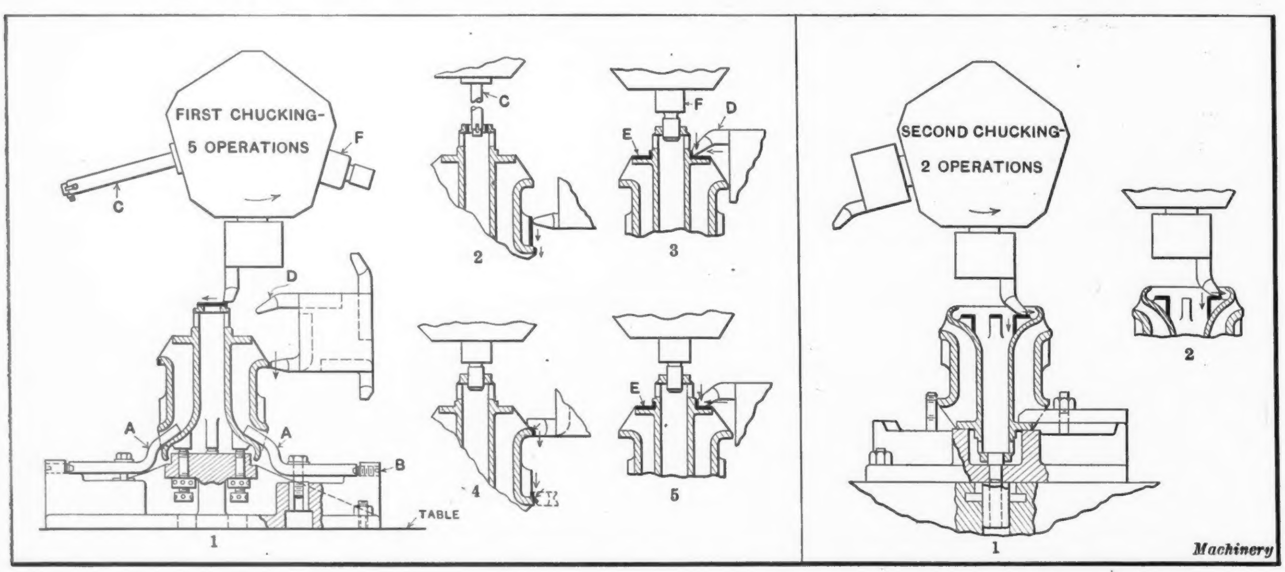


Fig. 18. Tooling Lay-outs for machining a Locomotive Valve Body. Attention is called to the Special Holding Means employed

Common Causes of Errors in Machine Design

Physical and Chemical Laws Affecting Design—Functioning of Parts—Clearance between Parts—Suitability of Materials—Strength of Parts—Durability—Adjustment—Simplicity

Second of a Series of Articles

By R. H. McMINN

THE first installment of this series of articles, which was published in the January number of MACHINERY, discussed errors that are commonly made in machine design, and their basic causes. Twenty-nine important factors which should be considered in the design of a machine were outlined, and the first two points, relating to authority affecting the design of a machine, and the completeness and accuracy of information required, were discussed in detail. The present installment will treat of physical and chemical laws affecting design; functioning of parts; speed and timing of relative motions of parts; positiveness of action; clearance between parts; suitability of materials; strength of parts; durability; adjustment; simplicity; accessibility of parts; and lost motion.

Physical and Chemical Laws Affecting Design

A designer should have as thorough a knowledge as possible of physical laws. If engaged only in mechanical work, he should know enough of physical laws pertaining to electricity to be able to use electrical equipment properly with other machines when required. A knowledge of certain chemical laws, such as those relating to combustion, is necessary in some lines in which the mechanical engineer works. A chemical effect, like rusting, is often evidenced or, as in casehardening, may be utilized in a machine which the mechanical engineer designs. But it is not sufficient just to know physical and chemical laws. The designer must recognize that a machine element under the prevailing conditions will act or be acted upon in a certain way because of one or more laws. He may know that "every body continues in a state of rest, or uniform motion in a straight line, unless it is compelled by force to change that state." However, he may overlook the fact that vibration is produced, because of this law, on a heavy rapidly reciprocating part, like a piston, due to the variation in the force necessary to accelerate it during each stroke.

One of the best safeguards against overlooking the effect of the action of certain laws in specific cases is a study of a thoroughly reliable and comprehensive treatise on the design of the kind of machine most similar to that which one is drawing. This will not only serve as a check on the work of the man who knows all the laws which should govern a design yet fails to allow for the effect of one, but will also be of even greater assistance to the man who may be ignorant of some of the laws which will affect results.

Functioning of Parts

The first step in design is the selection, arrangement, and proportioning of parts which, acting together, will best perform their functions in doing the work required. In order to be as sure of the successful operation of a new machine as possible, one should select, when possible, combinations of elements which have been used successfully before and which may be adapted to the conditions at hand. Not only must a careful analysis show that each element will efficiently perform its intended function but that no elements have been omitted that are necessary to fulfill the complete requirements. The machine may operate under variable conditions which may make the work variable and necessitate the addition of controlling devices. It may require means for reversing not thought of at first. In a self-propelled vehicle the main feature is the propulsion, but the vehicle must be guided, backed, controlled in speed, and stopped, all of these requirements demanding additional elements to perform the various functions.

In a punch press the main work is punching holes in metal, but the machine must be started and stopped at will, means must be provided so that the cross-head carrying the punch will stop at the top of any single stroke, and in some cases an automatic feed for the metal being punched is included in the design. The main work performed by an elevator is lifting and lowering loads, but the design must not only include devices for normal conditions of operation but also appliances, such as the safety stop and the slack cable device, which act only in the event of failure of some other element.

The consideration of what the complete requirements are in the design of any machine will therefore demand much thought. Since the design of most modern machines is the result of gradual development, it is probable that no one starting on the design of a machine new in kind to him will think

The author of the series of articles on "Common Causes of Errors in Machine Design" has made a careful study of drafting-room errors, their underlying causes, and the reasons why designs are not always what they should be. Draftsmen as well as experienced designers will benefit by studying these fundamental causes, which have been analyzed and recorded after a long series of observations backed up by years of diversified experience. While all designers realize the importance of preventing errors as far as possible, it is not generally appreciated that these errors can be reduced to a minimum by making a study of the fundamental reasons for them and by systematically applying such methods as are likely to prevent the occurrence of common errors.

of all the elements which should be included in the design without a preliminary study of similar machines.

Speed and Timing of Relative Motions of Parts

There is usually some determining factor that sets the speed of some elements of a machine, as, for instance, the number of revolutions of the crankshaft of a gas engine required for a certain service, the number of strokes per minute of a punch press needed for a given output, or the number of feet per minute lift wanted for an elevator cage. The speed of the other parts depends upon their function and point of application in the machine.

Members like cams, which operate other parts intermittently, must be arranged to perform their functions not only the proper number of times during a complete cycle of operations of the machine, but also at the proper periods of time. The first condition must be insured entirely at the time of design by providing for proper relative speeds of members. The fixing of the exact period of time at which one part will perform its function, in relation to the period of time at which the other parts perform their functions can often be set during assembly, but this possibility must be ascertained during design.

In Fig. 2 two cams *A* and *B* are keyed to the shaft *D*, which is driven by a gear *R* from a pinion *S* on another shaft *E*, which also carries a cam *C*. The timing of the action of cam *C* in relation to the action of either *A* or *B* may be adjusted within certain limits during assembly by varying the particular pairs of gear teeth in mesh, even when no attention has been given to the angular location of keyways in cams and shafting. But the timing of the action of *A* and *B* in relation to each other can only be accomplished by fixing their relative angular relationships on shaft *D*. This must be attended to by providing the proper angular location of the keyways in the cams and shafting.

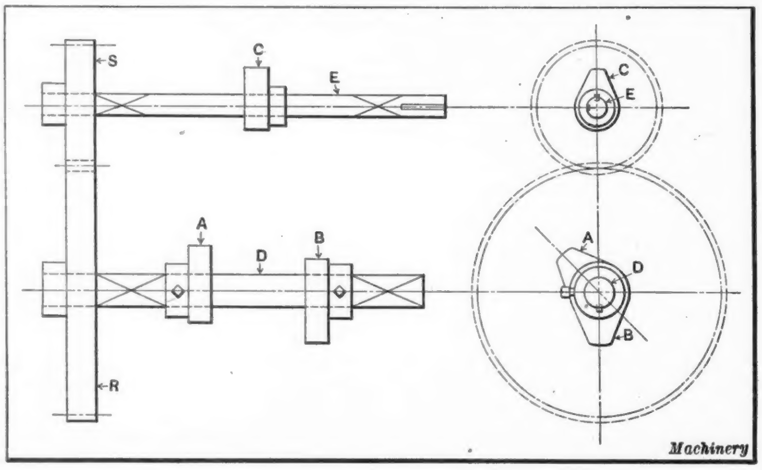


Fig. 2. Mechanism illustrating Factors controlling Timing of Parts

When the best results in timing the relative motions of the parts actuated by two cams like *A* and *B* are difficult to ascertain by drawing only, the cams are often set screwed on the shaft for purposes of adjustment and trial. If the turning moment on the cams is large, the location of keyways, which have already been cut in the cams, are marked on the shaft. The keyways are then cut in the shaft in the location thus marked for that and subsequent machines.

Positiveness of Action

The parts of a machine should generally be as positive in action as possible. This is especially true where a definite velocity ratio must be maintained between the parts. In ordinary cutting in a lathe, it is not necessary to have a precise ratio of forward movement of the carriage to the number of revolutions of the spindle. Here a slight slippage of the belt used to drive the feed-rod which produces the motion of the carriage and tool can do no harm; but in cutting threads it is necessary to connect the carriage positively through the lead-screw and a train of gears to the spindle which revolves the work, in order that the tool shall travel an exact amount forward for each revolution of the spindle.

Set-screws, when used in place of keys to prevent the turning of a part on a shaft, are intended to be positive in their effect, but frequently allow slipping under heavy loads. Parts actuated by weights, springs, compressed air, or magnetism must be checked carefully to see if they will work fast enough when used in conjunction with positively actuated parts having a high fixed velocity. Fastenings which depend on friction between the parts to hold them together are likely not to withstand vibration without loosening. In some cases, however, devices that are not positive are used purposely, such as friction clutches to eliminate the shock when starting a machine, friction brakes for gradual stopping, split wooden pulleys which are clamped on lineshafting for convenience, and belts because of their comparative flexibility in driving and simplicity in distributing power.

Clearance between Parts

The failure to allow enough clearance, or the occurrence of an actual interference between two parts of a machine, is one of the most common errors. The probable reason that interferences are often overlooked by draftsmen is because the necessity for determining clearances is not made a fundamental part of their earliest training in drawing. Their early drawing covers for the most part separate elements or a few elements associated together, and not a multiplicity of parts shown in difficult interrelation. Looking into clearance is therefore not second-nature. However, if a man is not definitely impressed with the grave danger of having an interference between the parts of the machine he is designing, he will find this out by bitter experience; but even such an experience will not suffice to keep him out of a similar difficulty in the future unless he incorporates in his work a definite system for looking out for clearances, just as he watches other points of design.

Avoiding Interference of Parts when Making Drawings

The designer is aided in avoiding interferences if he is accustomed to working up all views of an assembly or lay-out as he draws, instead of completing one view and then starting another. It is impossible for him to conceive of all points involved in difficult geometrical relations if he has only one view before him and the rest in his mind. The assembly should be made complete enough and there should be enough views so he has a clear conception of all parts and all spaces between parts. Members such as bolts, grease cups, chains, ropes, and belts, which are frequently represented only by center lines, or sometimes not even indicated at all, are often found to interfere with other parts of a machine. Likewise the slack side of a belt or other flexible member may depart considerably from the straight line by which it is often shown. On the first design of a machine not entirely familiar to the designer it is a good plan to go into more minute detail in drawing than one experienced with that kind of machine would have to do, because of the suggestions of possible difficulties which parts actually shown give and which parts not shown may not give. One of these difficulties is in the assembly of the parts. Often a bolt, indicated only by a center line, would clear other parts in its final location if there were a way to get it into the place intended. Likewise, it is not always as evident that a center line in motion will hit another part as it is that the grease cup, which the center line represents, will interfere with the part. When drawing work is abridged too much, it is likely to cause trouble. The drawing should be such as to lend every possible assistance in avoiding error.

All parts must not only clear in the positions in which they are shown on the drawing, but the path of all moving parts must be examined to see if they will clear all stationary parts and all other moving parts during any cycle of operations through which the machine must go. This may necessitate a number of separate lay-outs of various groups of parts viewed from different angles solely to determine clearances. Plenty of clearance must be allowed between unfinished parts and large castings which may vary considerably from the actual dimensions on drawings.

Liquids and Gases

Liquids and gases should be considered especially in reference to the subject of clearance. Air is not represented on a drawing, except sometimes in drawings of air-operated machinery. It occupies space, however, and nothing can be put into that space until the air is allowed to escape. If a shaft must be plunged into a deep hole in which it fits very closely, there must be some means for allowing the air to escape from the bottom of the hole. This is especially true if the shaft has an in-and-out movement in the hole during operation. Similarly, water cannot completely fill a piping system until the air is removed. The heating of a steam radiator is greatly retarded unless the air in it is allowed free escape.

Ordinary methods of finishing surfaces and holding them in contact are not sufficient to prevent liquids and gases from escaping between the surfaces because the space between the particles composing the surfaces is relatively large in comparison with a molecule of a liquid or a gas. Permanent joints which must be liquid- or gas-tight are made so by calking, welding, or the use of molten metal, such as solder or lead, to seal the joint. Joints that must sometimes be disconnected have rubber, asbestos, or soft metal gaskets which, when compressed, fill all the surface pores of the harder metals. Tapered threads are also used on screwed members to make tight joints. Some joints must hold gases and liquids but allow relative movement between the surfaces in contact. Thus leather cups are used for air or water pistons; fibrous or metallic packing is used for stuffing-boxes around piston-rods; ground valves have ground seats; and ground piston-rings work in ground cylinders.

Suitability of Materials

There are many chances of specifying a wrong material of construction unless this be given full consideration. The selection of any material for a certain purpose may depend on one or more qualities, such as strength; durability; flexibility; fire-resisting ability; cost; weight; ability to cast, harden, bend, or weld; electrical conductivity; insulating properties; or ease of machining. One of the considerations in the selection of a material is how it will be acted upon by other materials with which it must come in contact. Some metal alloys are especially prepared for their acid-resisting properties. In sliding contact, two unlike materials are used generally, because they have a lower coefficient of friction than two parts of like material and consequently require less work to move and wear better. However, cast-iron piston-rings are used on steam- and gas-engine pistons working against cast-iron cylinder walls with better results than rings of other materials. Brass is used in many places where cast iron might otherwise be used, because the former will not rust in the presence of moisture. A rawhide pinion may be used with a metal gear to reduce noise of operation.

If a designer introduces elements into a machine to perform functions or which will be surrounded by conditions with which he is not entirely familiar, it would be well for him to obtain a check on his own judgment regarding the selection of materials for these elements.

Strength of Parts

The strength of the parts of a machine or structure should always be carefully considered. In some machines, like typewriters and adding machines, the strength of many of the parts does not actually require figuring. One knows from experience that the smallest size that it is practicable to make some of the parts will be amply strong for the stress upon them. Even in larger machines there are parts which do not require figuring to determine that a certain size will be strong enough to resist the stress they must undergo. But it is well to form the habit of always considering the strength of a part, whether its safe proportions can be fixed by an instant's thought or require an elaborate calculation to determine.

One of the important elements in figuring strength of members is in observing all the forces which are acting, what members they affect, and how they affect them. This can often only be positively determined by a thorough examination and analysis. The parts must be able to resist not only their normal working load but also any suddenly applied load which may come upon them. This may not come from outside sources, but may be produced by the sudden stopping of the machine itself, as from the momentum of heavy parts when a brake is abruptly applied. Also, the power required in starting a self-propelled machine, such as a street car, or any machine starting under full load from rest far exceeds the power required for normal running and gives a consequent higher stress in many of the parts. The stress produced by centrifugal force must be watched carefully in rapidly rotating parts. The weight of a member such as a beam, chain, or cable, which is supporting a load must often enter into the calculations in determining the total load to be resisted by the member, if its weight is an appreciable per cent of the other loads.

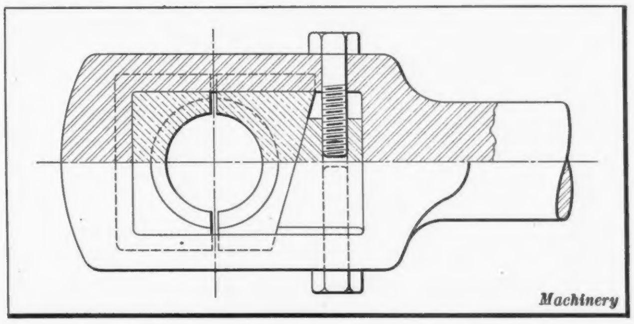


Fig. 3. Example illustrating Screw and Wedge Adjustment for Bearings

The proportions of some parts, such as shafting, must be such that under maximum loading a certain deflection from their normal shape is not exceeded, to prevent excessive binding in the bearings. The necessity of reducing vibration may require that parts like a machine frame be made heavier than needed by considerations of breaking strength alone. A member can be subject to one simple stress, such as compression, tension, shear, or torsion, or to bending (which combines tensile, compressive, and shearing stresses), to bending and torsion, and other combinations.

Initial Stresses

Some castings, notably wheels and pulleys, are subject to initial internal stresses due to unequal cooling, and therefore a conservative unit stress must be used in figuring their strength. Unequal expansion or contraction of connected parts in a machine due to a radical change in temperature may result in greatly increased stresses. In steam piping this must often be allowed for by expansion joints.

Stresses due to Assembling

The required size of a bolt or screw in a machine may depend upon its ability to resist breaking by over-tightening rather than upon any other stresses to which it is subjected. The thickness of the metal of a hub into which a shaft must be driven or forced must be sufficient to resist this process even when a much less thickness may be needed to withstand

operating stresses. The strength of a part may depend primarily upon its ability to be carried through all the processes of manufacture and transportation without breaking, rather than upon any strain to which it may be subjected in the operation of the machine.

Factor of Safety

The allowable unit stress in any member is obtained by dividing the ultimate unit strength by a factor of safety. This factor under a steady load depends upon the elastic limit of the material and its reliability. When the load is not steady, the factor must be increased by an amount depending upon the variation in intensity, direction, and suddenness of application of the load. It must also be large enough to allow for overloads (if they are possible) and uncertainty as to exact methods of figuring the strength of some members. The factor to allow for any part depends somewhat upon how often a load is applied to it in relation to other parts of the same machine and upon what the consequences of its breaking would be either in cost of replacement, in delay to production, or in actual danger to life.

Durability of Machine Parts

The durability of the parts of a machine is another important element to be considered. The limitation of the wear on any part may largely determine its size. The size of an engine crankpin which runs in one of the connecting-rod bearings is generally based on the allowable bearing pressure and then checked for strength and stiffness. The design of slides, clutches, and brakes partly depends upon allowing sufficient areas in contact to reduce wear. The teeth of gears operating under conditions where they are subject to the action of sand or similar materials should be made much larger than demanded by the initial strength needed in order to allow for the rapid wear, with consequent weakening, which is bound to occur. Parts may have to be increased in size or thickness to allow for rust or corrosion. The kind and grade of materials used as well as certain special treatments to which they may be subjected, as in hardening and tempering steel, also have an important influence on their ability to resist wear.

Adjustment of Machine Parts

Almost all machines require means of adjusting one or more members to take care of the variable sizes of the work handled, to make certain parts the exact size required, to locate a part more exactly than it can be done by other means, or for other reasons. It is difficult to align bearings unless they rest on the same rigid machine bed. In hangers for lineshafting the center of a bearing can be adjusted up or down by screws, and laterally by means of slotted holes in the top of the hanger. Thin liners of metal or cardboard are often used between the halves of bearings so that when the bearing wears, one of the sheets may be removed and the two halves brought closer together. Some important bearings have means of adjustment by screws and a wedge, like the connecting-rod bearing shown in Fig. 3.

Gas engines are provided with mechanism for adjusting the timing of the spark and varying the mixture of gas and air. Machine tools are provided with adjusting means to bring the cutting tool in contact with parts of different size and shape. The cross-head of a punch press often has a connecting-rod adjustable in length so that the punch, which is attached to the bottom of the head, may be made to enter the die to just the correct depth at the bottom of the stroke. The designer must always note whether any adjustments should be embodied in a new design, either by necessity or for convenience.

Simplicity of Construction and Accessibility of Parts

Simplicity of construction is one of the features to be sought in design at all times. The machine should have as few parts as possible and as few kinds and sizes of parts consistent with what the parts do. The first operative mechanism one may think of to perform a certain function may not be the simplest to be found. Possibly approaching the problem from an entirely different viewpoint may suggest a much simpler one. If thought directed to finding a better one fails, certain parts of the first mechanism can probably be combined to advantage. If a machine has parts remote from each other which perform the same functions, it is possible that by a relocation of certain groups some duplicate parts can be eliminated.

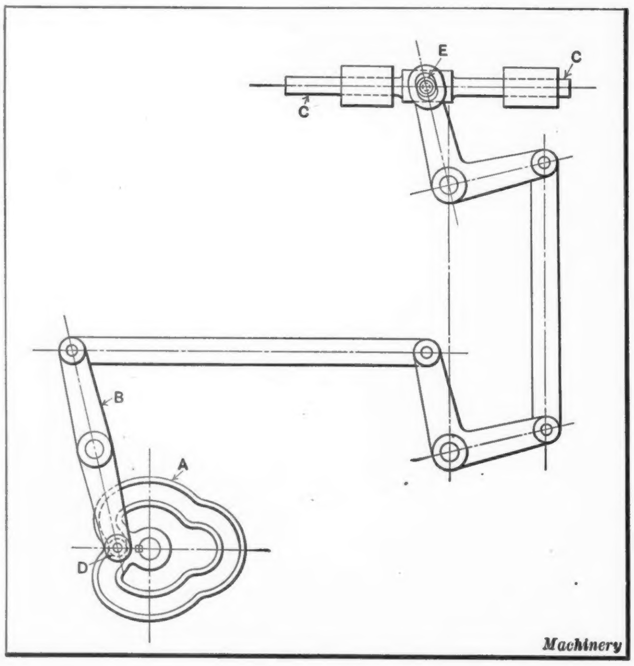


Fig. 4. Type of Mechanism in which Action of Driven Member is reduced somewhat by Lost Motion

It is said that on one of the earliest steam engines a boy was required to move the slide-valve back and forth to produce the reversal in direction of motion of the piston. He observed that there was a part on the engine that moved in unison with the slide-valve, so he attached a stick between them, which did the work that he had been required to do.

Making parts symmetrical in as many ways as practicable may allow one kind of part to be used in more than one position on a machine. One should try to avoid making parts which require right- and left-hand patterns or dies, but must be sure to discover when they are necessary. The attempt to make a machine with the fewest parts does not mean only that as many parts as possible should be cast or formed integrally. Full consideration should be given to required differences of material, ease of machining and assembling, differences in wear of parts, and ease of adjustment and replacement.

It is important that the user of a machine be able to reach or remove certain parts of the machine easily. In fact, accessibility of those parts must greatly determine design if the machine is to be permanently satisfactory to the purchaser. A machine with a considerable number of parts cannot be made so that every part may always be reached or removed without removing any other part. However, parts which require frequent inspection, cleaning, tightening, adjustment, packing, lubrication, or removal for regrinding or replacement should be accessible by the removal of the least possible number of parts. One of the chief advantages of the Walschaerts valve gear, which is one of those displacing the Stephenson link motion in the control of locomotive slide-valves, is that the former is located outside of the driving wheels and hence is more accessible for repairs than the latter, which is placed between them.

Allowing for Lost Motion

The lost motion in any mechanism will often have to be taken into account. In Fig. 4, a cam *A* imparts to a lever *B*

an oscillatory movement and, through a series of links and levers, gives a reciprocating movement to the rods *C*. The theoretical movement of the rods depends upon the arc of action of lever *B* and the arrangement and lengths of the other levers and links. The actual movement of rods *C* will be less than this because of lost motion. A part of this lost motion might be due to the distortion in the various members, if they are highly stressed, but the greatest part will be due to the working clearance at each pivoted joint and between the rollers *D* and *E* and the sides of the slots by which they are actuated. The clearance may be small at each of these points, but it has a cumulative effect. The wear at all such points will, of course, increase this lost motion. In mechanisms transmitting small forces, lost motion and wear can sometimes be allowed for by proportioning the movements to give a slight initial over-travel to such parts as rods *C*. If this is not permissible, provision can be made for adjusting the length of one of the lever arms and links so that the required movement may be imparted to the last member of the series.

When machine members transmit large forces, which are constantly reversed in direction, lost motion between the members tends to produce shocks on their bearing surfaces, thereby hastening wear and causing vibration. To avoid such conditions the bearings affected should be provided with adjustable means so they may always have the closest practicable fit on their journals. This is done on steam-engine connecting-rods in a manner similar to the example shown in Fig. 3.

If gears are members of a reciprocating mechanism, they will also allow lost motion unless the clearance between the sides of the teeth is kept at a minimum. They should therefore be accurately cut and mounted with shafts having exact alignment and center distances. The slightest lost motion of the spindle of a micrometer would introduce inaccurate readings. This is prevented by having two stationary nuts through which the spindle screws. These are pushed apart by a spring between them, or adjusted manually so that they press equally against the spindle threads in both directions. This prevents a longitudinal motion of the spindle without its being turned and hence registering its movement by the graduations provided. When it is necessary to devise a mechanism having a minimum of lost motion, one with the least number of joints should be sought. The type of joints that is selected should, if possible, be capable of adjustment for wear.

The next installment of this article, which will appear in the March number of MACHINERY, will deal with additional important factors in the design of a machine, such as frictional losses, lubrication, unbalanced parts, manufacturing operations, and other points.

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BLANKING, FORMING AND PIERCING DIE

By C. J. HUEBER

The die here described and illustrated has given excellent results in the production of metal flanges used in the manufacture of rubber-cushioned wheels for a vacuum cleaner. As shown in Fig. 1, the finished wheel is made up of four parts; a rubber cushion *A*, an assembling tube *B* which forms the bearing, and the two pressed-steel flanges *C*. The die shown in Fig. 2 is used to blank, form, and pierce one of the flanges *C* in one operation, and when in use is mounted on a single-action inclinable press.

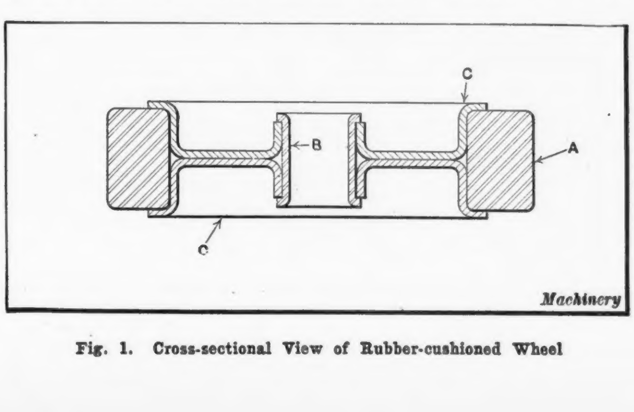


Fig. 1. Cross-sectional View of Rubber-cushioned Wheel

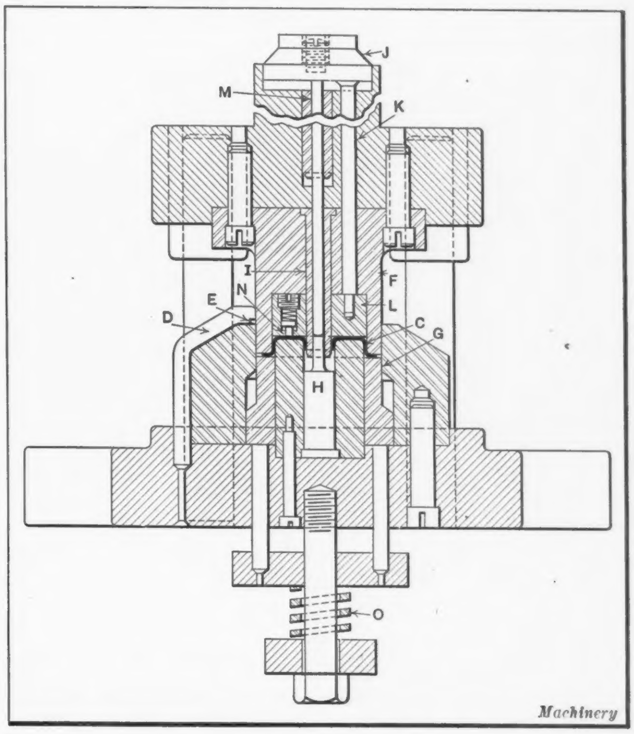


Fig. 2. Die used in blanking, forming and piercing Flanges C shown in Fig. 1

Cold-rolled steel 0.035 inch thick, cut or sheared into strips 3⅞ inches wide, is used for making the flanges. This permits a double run to be made on the stock, as the blank is approximately 1 61/64 inches in diameter. The stock is fed to the die and gaged by two hook pins *D*, only one of which is shown in the illustration, the other being located at the back of the die. These pins are under-cut as shown at *E* in order to strip the scrap from punch *F*. As punch *F* descends the flange is cut, the blank being held by draw-ring *G*. As the punch continues its downward stroke, the hole is pierced by punch *H*, and the hub of the flange is drawn around die *I*.

Flange *C* is completed by the downward stroke when draw-ring *G* is seated on the die-shoe. On the return stroke, knock-out *J* strikes a cross-bar on the press, which causes the stamping to be ejected from the punch by means of studs *K* and pad *L*. Knock-out *J* also actuates rod *M* which ejects the small slugs from die *I*. The small spring-operated pin *N* is also employed to overcome the difficulty arising from the tendency of the stampings to adhere to pad *L* due to oil on the stock. As customary in all drawing dies used on a single-action press, a spring *O* or a rubber bumper must be used for applying pressure to the draw-ring.

* * *

SAFE FOUNDRY PRACTICE

A booklet entitled "Safe Foundry Practice" has recently been published by the engineering and inspection division of the Travelers Insurance Co. This booklet describes the sources of accidents in connection with the production of castings, being devoted mainly to iron foundries. Many of the safety problems encountered in foundries where other kinds of metals are cast are also considered. The booklet also treats of safe wearing apparel of employes, and the apparatus essential to the work of the foundry. The hazards associated with chipping, grinding, and sand-blasting are dealt with, and helpful suggestions are given in regard to illumination. The safety problems that arise in the foundry yard are also discussed.

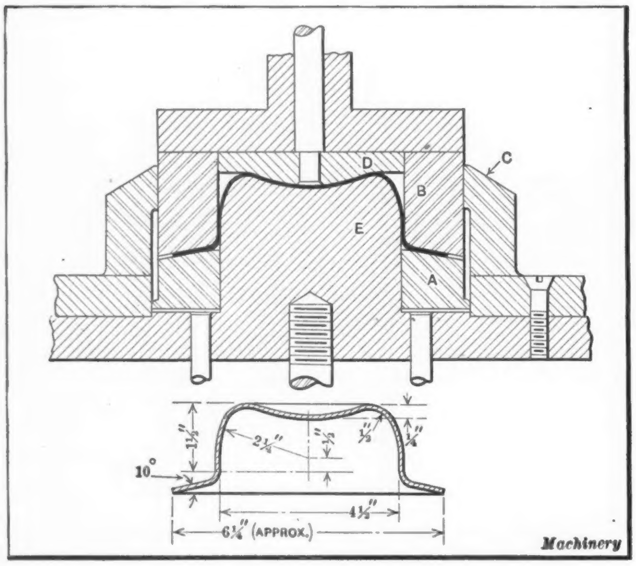


Fig. 1. First-operation Die for Hemispherical Shell

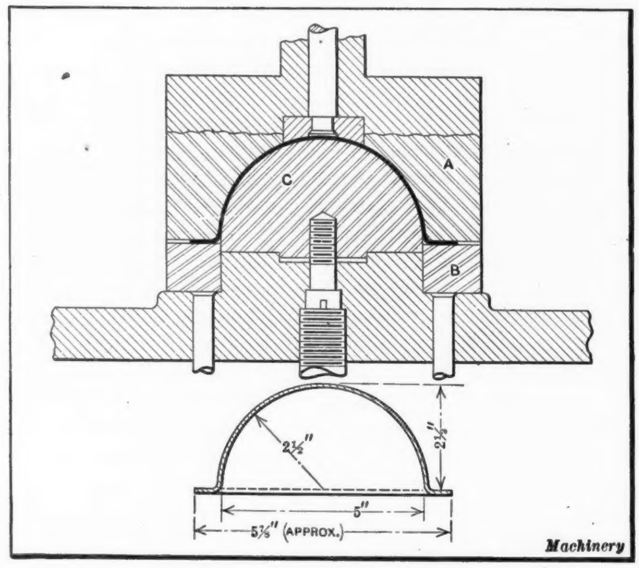


Fig. 2. Die in which Shell is formed to Shape shown

Dies for Hemispherical, Conical and Other Flanged Shells

By J. BINGHAM, President, B. J. Stamping Co., Toledo, Ohio

THERE are various ways of making hemispherical shells, but dies designed as illustrated in Figs. 1 and 2 may be used effectively to produce work of this kind. Of the two dies used in making these shells, which are for ball floats, the first is shown in section in Fig. 1 together with the work after the completion of the operation in this die. The shell is made from a 7 3/16-inch diameter blank of sheet copper, 0.007 inch thick, and its position in the die is shown in heavy lines. By referring to the dimensioned drawing of the shell, it will be seen that it is drawn straight for about ½ inch, and then is formed to a radius of 2¼ inches. It will be seen that the finished shell, Fig. 2, has a radius of 2½ inches, so that by first drawing the shell to the smaller radius, provision is made for stretching the metal to the finished size. In dies of this type it is necessary to provide full round corners in every part of the shell so that during the stretching operation, no drawing marks will be in evidence on the shell.

The combination die in Fig. 1 and the finishing die in Fig. 2 are of similar construction, and their method of operation is identical. The principal parts of the die shown in Fig. 1 are the forming die *E* which is made of cast iron, the drawing ring *A*, the punch *B*, and the blanking die *C*. The latter three parts are made of tool steel, and are hardened and ground. The drawing operation is accomplished by forcing ring *A* downward, drawing the blank over the die *E* against the pressure exerted by a rubber buffer attachment of familiar construction. The drawing punch *B* is welded to a wrought-iron holder, which is an economical construction. A machine steel former *D* is attached to the punch for producing the concave part of the shell. It will be noted that the blanking die *C* is also of a two-piece construction, the tool-steel and wrought-iron parts being welded together.

Referring to Fig. 2, when punch *A*, which is made of tool steel with a wrought-iron upper portion, is in its raised position, the shell, on which the first operation has been performed, is placed on the tool-steel die ring *B*, the concave part of the shell fitting over the convex part of the die *C*. Since the shell is ½ inch smaller in diameter than the finished part, it is evident that punch *A* can pass over the shell in this position, so that the surfaces of the punch and of the die ring can grip the flange under the pressure exerted by a rubber buffer attachment, and hold the shell securely. As the punch continues to descend, forcing the die ring down-

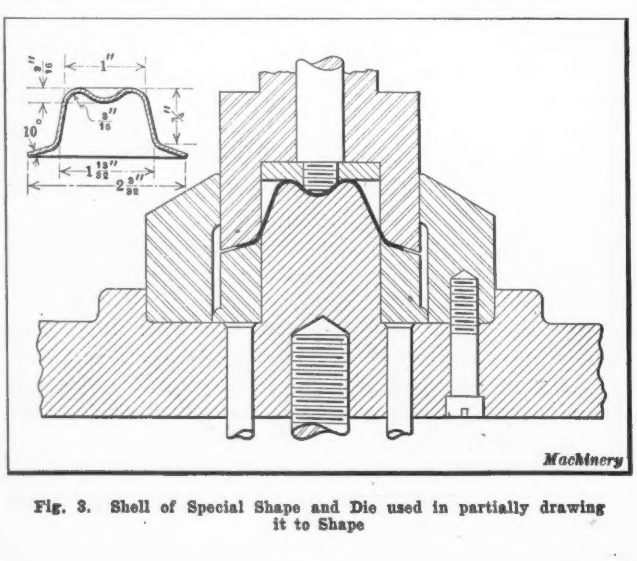


Fig. 3. Shell of Special Shape and Die used in partially drawing it to Shape

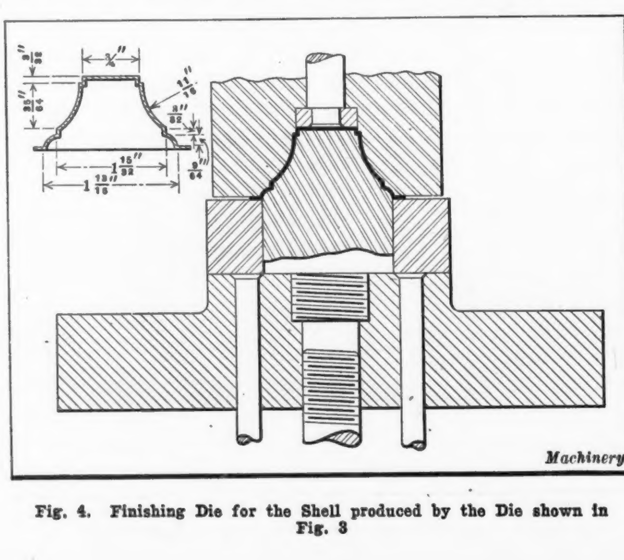


Fig. 4. Finishing Die for the Shell produced by the Die shown in Fig. 3

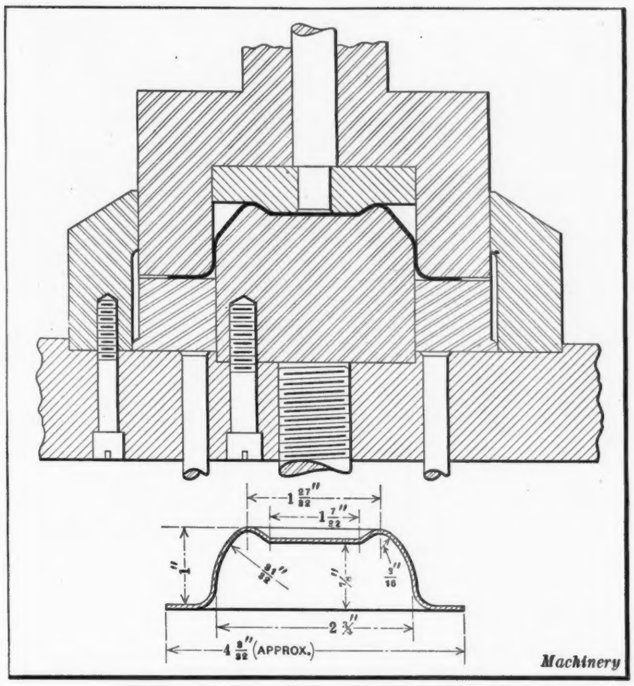


Fig. 5. First Die used in drawing a Flanged Conical Shell

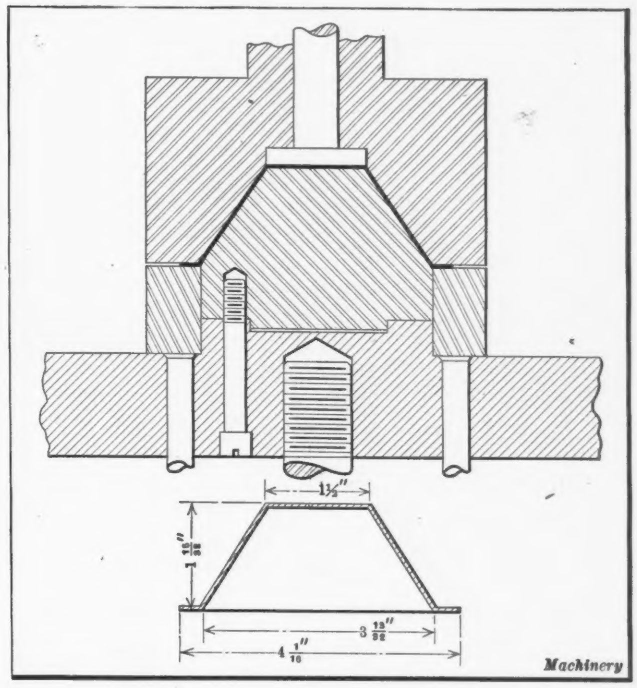


Fig. 6. Die in which the Conical Shell is completed

ward, the shell is simply stretched over the tool-steel die on which it rests. Not only is the shell stretched, but its diameter is also expanded, and it is this combination that enables a smooth shell, free from wrinkles, to be produced. After this drawing and expanding operation has been completed, the edges of the shell are trimmed, and the two halves closed together, thereby completing the copper float.

There does not appear to be any hard and fast rule governing the difference in diameter between the first-operation shell and the finished product, although it has been found by experience gained in making several balls by this method, that from 3/8 to 1/2 inch is a fairly close approximation. This amount, of course, depends upon the size of the shell; if the diameter is less than 3 1/2 inches it is probable that the amount of expansion would be about 3/8 inch, whereas, for a 2-inch diameter shell it would not be advisable to allow more than 1/4 inch. The principal consideration, however, is to make sure that the punch can pass down well over the shell and securely hold it by the flange before the expanding and stretching starts.

The two dies shown in Figs. 3 and 4 are employed for making stove urns, and these flanged shells, while of special design, are produced on dies operating on the same principle as those previously described. For that reason a detailed description of their construction will not be given, but in order to make clear the application of the method explained in the preceding paragraphs to the manufacture of other shells of this general type, these two designs are illustrated, together with the dimensioned shells produced by each. The blank from which the stove-urn shell is drawn is 2 5/8 inches in diameter, and is made of cold-rolled sheet steel, 0.022 inch thick.

Another set of dies which operates on the same principle as the dies already mentioned, is shown in Figs. 5 and 6. These dies are used in the production of a conical shaped shell for cream separators. It is imperative that these taper shells be drawn without wrinkles or drawing marks of any kind, and their tapered surfaces must be perfectly straight. These cream separator shells are made from cold-rolled sheet steel, 0.019 inch thick, the diameter of the blank being 4 7/8 inches.

Accompanying each illustration there is a dimensioned drawing of the shell, so that an idea of the change produced by each operation may be readily seen. Two more dies of the same general classification as those previously mentioned are shown in Figs. 7 and 8. The work produced in these dies is shown in Fig. 7 in its preliminary stage, and in Fig. 8 the finished work is shown by a heavy line. These shells are oil-can breasts, and the metal is sheet steel, 0.018 inch thick, the size of the blank being 7 5/16 inches in diameter.

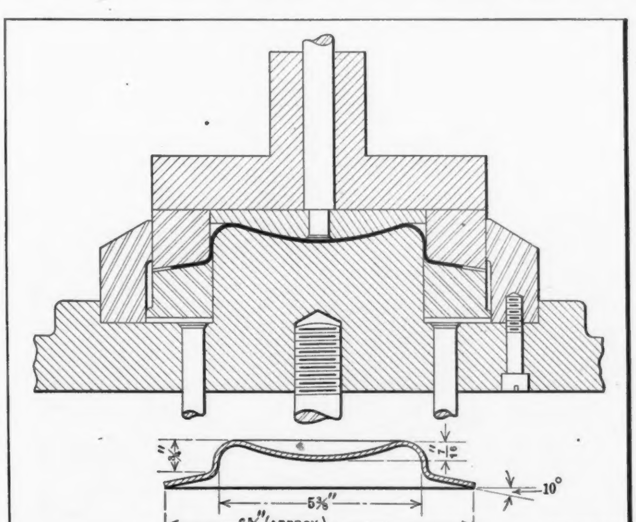


Fig. 7. Die used for partially forming Oil-can Breast

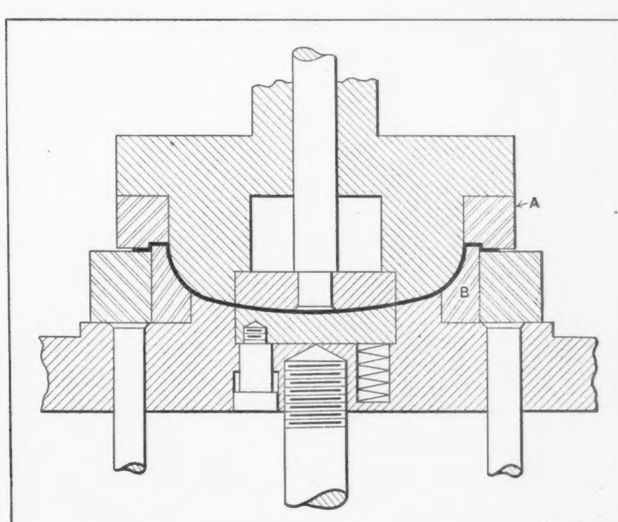


Fig. 8. Die used to finish-form Oil-can Breast

Fig. 1. Reproduction of Unretouched Photograph taken at Night which shows Effectiveness of Lighting System in Machine Section of the Acme Machine Tool Co.'s Plant, at Cincinnati, Ohio

The die used in the preliminary drawing operation presents no unusual features of construction, but it will be seen in Fig. 8 that the position of the work is inverted, and consequently the construction of the die is slightly different. The punch and die rings *A* and *B* form the shoulder flange and so are slightly different from the corresponding parts of the dies shown in the other illustrations. A spring pad in the die provides for lifting the finished shell from the die-nest so that it may be readily removed. The basic principle of operation, however, of all these dies is the same. All of the parts mentioned in this article have been manufactured by means of the dies illustrated, which have proved entirely suitable for work of this type.

* * *

PRODUCING DAYLIGHT EFFECT BY ARTIFICIAL LIGHTING

The lighting conditions in a machine-building plant have a far-reaching effect, both on the quantity and quality of the work produced. Realizing this fact, those in charge of shop construction and the makers of lighting equipment have for some time devoted considerable attention to the improvement of lighting systems. Designers and architects have progressed rapidly in the development of sawtooth roofs and other means of obtaining the best natural lighting conditions, and designers of artificial lighting systems have also made rapid progress, as is evidenced by the accompanying illustrations, Figs. 1 and 2.

These two illustrations are reproductions of photographs taken at night in the Acme Machine Tool Co.'s plant, Cincinnati, Ohio, considered by lighting experts one of the best lighted machine tool plants in the country. The photographs were not retouched in any way, and therefore bear testimony to the effectiveness of the type of lighting system with which the plant is equipped. From these reproductions of photographs taken at night with no illumination other than that furnished by the regular Cooper-Hewitt lighting installation, it is evident that practically a daylight effect is obtained. It will be noted that fine details stand out sharply and shadows are practically eliminated. Fig. 1 shows a night view of a machine section, and Fig. 2 shows a night view of the high assembling and erecting aisle. The complete lighting installation in each case consists of 138 Type P Cooper-Hewitt lamps. Practically all productive sections of the shop are lighted by these lamps at an average of 1.36 watts per square foot. The normal cost of maintenance of this lighting system is said to have averaged about $1.50 for each lamp per year.

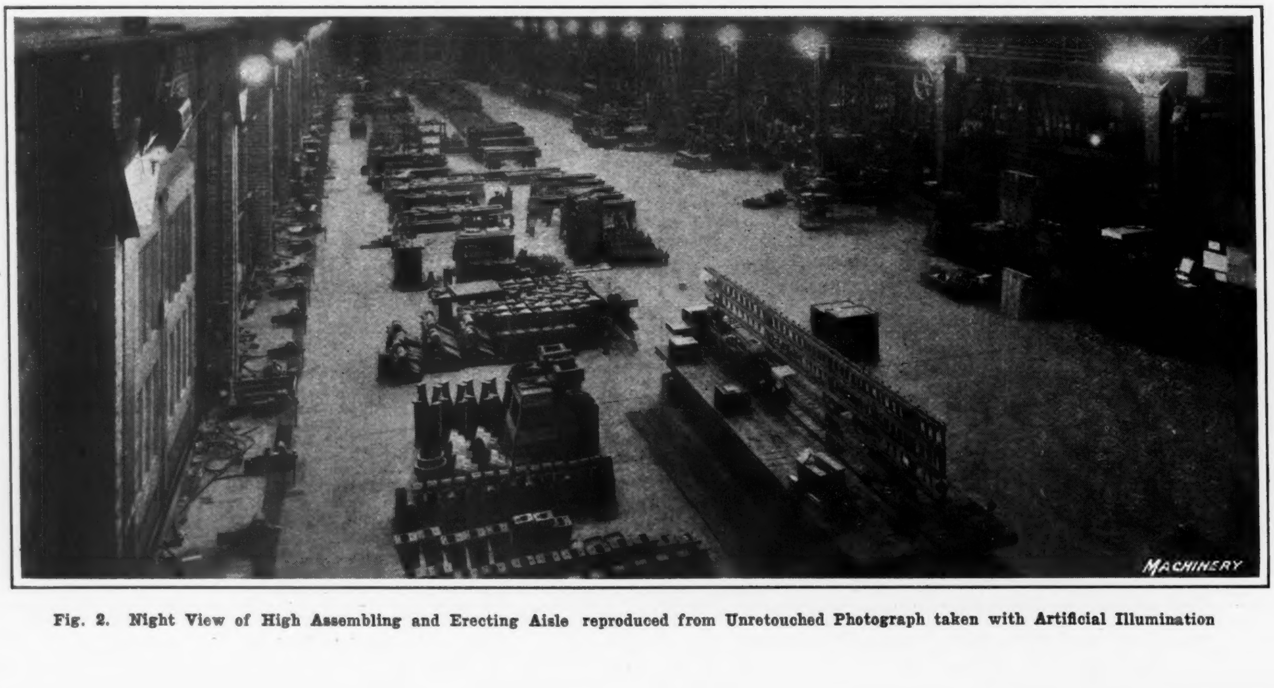


Fig. 2. Night View of High Assembling and Erecting Aisle reproduced from Unretouched Photograph taken with Artificial Illumination

Encouraging Industrial Cooperation

By A. H. DITTMER, President, Dittmer Gear & Mfg. Corporation, Lockport, N. Y.

THIS article deals with a new idea in industrial management, which is in successful operation at the plant of the Dittmer Gear & Mfg. Corporation, Lockport, N. Y. This company has instituted what is known as a credit point bonus contest, which is closely identified with its regular bonus system. Before describing the credit point system, an idea will be given of the regular bonus system used.

Efficiency Percentages for Determining the Amount of Bonus

When a man is hired, he is given a flat hourly rate, and he receives this rate as long as he remains on work which is not classified under the bonus system. As soon as he has been put on a job that requires him to work under the bonus system, he is given an opportunity to fix a standard that will represent the amount of work that he should do in a given length of time working at a normal speed and under average conditions. The standard which he thus establishes, working to a stop watch, is accepted by the company as a 100 per cent efficiency mark. As long as the operator can produce 67 per cent of this established standard, he is paid his regular flat rate, but this 67 per cent is a low average for a workman to maintain, for a man whose production drops 33 per cent as compared with what he is able to do under normal conditions is not the kind of man that an efficient organization is desirous of keeping on its payroll, unless there is a good excuse for such a drop.

Starting with the low limit of 67 per cent of the established hourly standard, a chart has been prepared in which all the efficiency percentages up to 180 per cent are listed, and arbitrary bonus percentages given for each efficiency percentage, so that the amount to be added to the man's flat hourly rate can be readily calculated. There is no bonus for 67 per cent efficiency; for 70 per cent efficiency, there is a 1 per cent bonus; for 75 per cent efficiency, 3 per cent; for 80 per cent efficiency, 5 per cent; for 90 per cent efficiency, 10 per cent; for 100 per cent efficiency, 25 per cent; and for each per cent increase in efficiency above 100 per cent an additional 1 per cent in the bonus rate is made. This brings the bonus rating for the maximum efficiency of 180 per cent, provided for on the chart, up to 25 + 80 or 105 per cent.

Perhaps the method by which the bonus is figured will be better understood by taking a concrete example. The record of the earnings of each man working under the bonus system is kept on bonus record charts such as illustrated in Fig. 1. It will be seen that in this case the operator worked on a number of different operations during the week, and that in establishing the efficiency percentage, the total week's work is considered. Referring to the fourth item on this record, it will be seen that operation 66B was performed on twenty-five pieces in four hours' time. The standard established for this particular operation is seven pieces per hour, so by dividing the number of pieces of work by this standard, the number of standard hours 3.57 is obtained. This is slightly below 100 per cent efficiency as can be readily seen, but in the case of the second item the efficiency percentage is dangerously low. However, by considering the totals for the week it is seen that in 63.25 hours, the work of 68.66 standard hours was accomplished. Dividing the number of standard hours by the actual number of hours consumed, gives the efficiency percentage of 108 for the week.

Dittmer Gear & Manufacturing Corporation

BONUS RECORD

Employee Harrington J. D. Clock No. 56 Week Ending Sept 21 1920

Date	Part No.	Operation No.	Pieces Finished	Time: Actual Hrs.	Time: Stand. Hrs.	% Effy.	Bonus Period Time Earnings	Bonus Rate	Bonus Earnings	Pro Rata to Costs
9/15	d 21	50	90	7.00	5.00		3.00			0.99
	12	56a	15	1.25	0.68		0.62			0.20
16	"	"	77	3.50	3.50		1.75			0.58
17	"	66B	25	4.00	3.57		1.00			0.33
	"	66a	28	4.00	4.66		1.00			0.33
18	"	"	29	4.25	4.83		1.00			0.33
	"	66B	34	4.25	4.85		1.13			0.37
20	"	"	76	9.00	10.85		2.25			0.74
	"	66a	70	9.00	11.66		2.25			0.74
21	"	66B	58	8.00	8.40		2.00			0.66
	"	66a	70	9.00	10.66		2.50			0.83
				63.25	68.66	108	18.50	33	6.10	6.10

Total Earnings during Bonus Period

Machinery

Fig. 1. Record Sheet on which the Weekly Bonus Earnings are kept, and the Efficiency Percentages entered

Now by referring to the chart of bonus percentages for various efficiency rates, the payroll department will be able to see at a glance that an efficiency rating of 108 per cent represents a 33 per cent bonus rating. That is, 33 per cent of the man's flat rate earnings for the period that he has worked under the bonus system or, in this case $18.50, represents the bonus earnings during that period of time. In this case the bonus earnings are $6.10, which is in addition to his regular flat wage. In the column at the extreme right, the extra costs above the regular flat rate are pro-rated for each operation, so that the cost accounts may be correspondingly corrected; 33 per cent of the time earnings for the bonus period for each job gives this amount, which is added to the cost of each job.

It is not intended to re-establish standards for different operators. Most jobs have previously been rated, and this standard must be the one used for all operators, regardless of their flat wage rate. If in the case of a job on which no standard has been set, a man is timed and produces twelve pieces per hour, this is considered the hourly standard; to obtain the standard hours, the total number of pieces produced in any lot is divided by this standard per hour. For example, if there are 720 pieces in a job and a man in establishing the rate, machines 12 pieces an hour, then the standard hours for the operation is 60. By dividing the standard hours by the actual number of hours required to do the work, which in this case we may assume to be 48, the per cent of efficiency is found to be 125. It was previously stated that 100 per cent efficiency yields 25 per cent of a man's rating as a bonus, and that for every per cent rise in efficiency a one per cent increase in bonus is made, so that in the example cited, 125 per cent efficiency represents a bonus of 50 per cent.

Special Bonus Provision for Set-up Men

Obviously the bonus system for the machine operators cannot influence the earnings of the set-up men, and also has no connection with the work of other non-producers such as inspectors. In order to create an efficient organization, such non-producers must be taken care of in the credit point bonus system, which is to be described later, and so special means are employed to enable these men to receive similar benefits to those paid the machine operators. The inspectors share in the benefits of the credit point bonus contest through their endeavors in maintaining high-grade shipments, as will be referred to later. In the case of set-up men, the following special bonus system applies. Each set-up man has a group of machines under his personal supervision; if these machines run without loss of time for a week, the set-up man is credited with 100 per cent efficiency, and from this credit, lost time caused by machine repairs, absent operators, etc., is deducted. The set-up man is also credited with 100 per cent efficiency if the operators on all the machines under his supervision make an efficiency rating of 100 per cent.

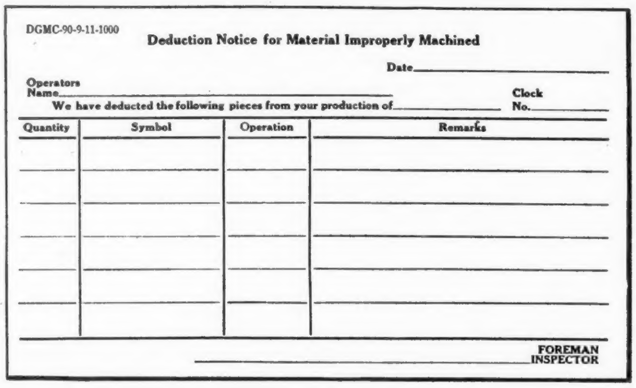
Both of these efficiency percentages are scaled down to 80 per cent, that is, if the set-up man registers 80 per cent on both these items he is paid his flat hourly rate. For each additional per cent over 80 for each of these items, he is entitled to ½ per cent of his rate as a bonus, so that if the set-up man registers 100 per cent for the week in both items, he receives a 20 per cent bonus. These bonus earnings are recorded weekly in a similar manner to the earnings of the regular productive man.

Rejected and Scrapped Material

It would, of course, be unreasonable to pay bonuses for rejected work; therefore, fair reductions must be made so that the company will not have to pay for work which is not properly machined. When it is necessary to make such a deduction in a man's earnings, the slip shown in Fig. 2 is made out in triplicate by the inspector, and one of these copies goes to the payroll attached to the bonus record, Fig. 1. The second copy is handed directly to the operator so that he may know before pay day all details in regard to the reason for making deductions. The third copy is retained by the inspector for future reference. After the proper deductions have been made in the payroll department, the bonus record with the deduction notice attached, is placed in the workman's pay envelope so that he can check up his entire bonus earnings without being obliged to ask for explanations from the clerical department.

The Credit Point Bonus Contest and its Conditions

Having described in detail the bonus system used in connection with the credit point bonus contest, the method of making awards under this scheme will be better understood. The contest was originally intended to run for a period of six months, but it is planned to renew the contest as soon as the present period has expired. In this way the contest constitutes an additional bonus system which takes into consideration not only the production end of the industry, but also all other factors which by special effort will add to the efficiency of the organization. A committee of men from the shop was selected for the purpose of conferring with the management in regard to improving the contest from time to time, for it was realized that such improvements would be necessary as the results of the contest became more in evidence. The general purpose of the contest is "to reward employes for initiative, loyalty, efficiency, and regularity, and to increase the efficiency of the plant in general."


DGMC-90-9-11-1000

Deduction Notice for Material Improperly Machined

Date______

Operators Name______ Clock No.______

We have deducted the following pieces from your production of______

Quantity	Symbol	Operation	Remarks

______ FOREMAN INSPECTOR

Fig. 2. Record Form on which Deductions for Poorly Machined Work are entered

The contest is a means by which additional awards may be earned for various things such as attendance, efficiency, etc. The basis by which the awards are made is by points, each point representing an award of 5 cents. Besides the various factors which are subject to awards under this contest, provision is made for paying special awards for ideas suggested which will benefit the organization. All employes, with the exception of the executives, are eligible to partake in this contest. The same amount, 5 cents, is used when penalizing the men for breach of established rules and regulations of the company, as is awarded for meritorious service or evidence of cooperation and loyalty to the concern. The following classification of subjects to receive the attention of the management in conducting this contest has been made:

1. Perfect attendance. When no time has been lost through absence or tardiness for one month, 40 points; two months, 50 points; three months, 60 points. For each additional month, 5 points are added until 80 points per month are reached, which is the maximum monthly award for attendance. Exceptions are made in case of sickness, death, or other serious matters, provided the management is notified to that effect.

2. One hundred per cent efficiency in production. First week, 5 points; second week, 10 points; third week, 15 points; each following week 20 additional points. To be eligible for awards for efficiency, the employe must have registered at least 35 bonus hours per week; that is, it is necessary for an employe to actually work 35 hours each week on bonus

work in order to become eligible for awards, regardless of the bonus per cent that the man may have registered.

3. Continuous service (not being removed from the payroll for any reason). Such service receives awards regardless of the attendance record. For three month's continuous service, 20 points; for six month's service, 25 points; for nine month's service, 30 points; and for each additional six month's service, 70 points.

4. Suggestions submitted and accepted. No award is made of less than 10 points, and no award is paid for suggested plans of improvements already under consideration by the management. The awards are based on the value of the suggestion, and may be increased as the suggestion becomes of greater value to the company.

5. Rate of scrap as determined by material and labor losses. The determination of the rate of scrap is made near the termination of the contest, and awards are made as follows: 1 per cent or less, 100 points; 1 per cent to 2 per cent, 75 points; 2 per cent to 3 per cent, 50 points; 3 per cent to 4 per cent, 25 points; above 4 per cent no award. These awards are paid to every person in the plant. Employes not having served through the entire bonus period benefit proportionally to their length of service.

6. Maintenance of high-grade shipments. These awards are made to inspectors only. For 100 per cent shipments, 25 points; for 1 or 2 per cent rejections the award is determined by the money value of the rejected work.

7. Gold medal or honor productive man (man having highest record for efficiency in production during a month), 25 points; gold medal or honor non-productive man (set-up man having highest efficiency percentage, and inspector having highest efficiency for monthly shipments), 25 points. Non-productive men such as inspectors, set-up men, etc., obviously do not have as good an opportunity of registering large numbers of bonus points as do the productive men, and for that reason each class is given a like consideration in making gold medal awards. This same policy is followed in every case where prizes are involved. There is an honor roll maintained in connection with the credit point bonus contest which is posted every week, giving the time-clock numbers of all men who have registered an efficiency percentage of 100 or better. It is the average taken from these weekly honor rolls that determines the awarding of gold medal prizes.

8. Miscellaneous credits and penalties subject to the special attention of the management. (a) Clean and orderly machines, desks, benches, etc., penalty or award 5 to 15 points; (b) clean and orderly condition of floor around machines, desks, etc., penalty or award 5 to 15 points; (c) carelessness in handling blueprints, penalty 25 to 50 points; (d) failure to use the provisions made for handling work, penalty 5 to 15 points; (e) smoking inside the shop or mutilating bulletins or notices, penalty discharge and loss of all points; (f) carelessness in handling materials, penalty 5 to 15 points; (g) promptness in making out reports and for being up to date in work, award or penalty 5 to 25 points; (h) failure to turn in gages between day and night shifts, penalty 5 to 15 points.

Additional Facts Regarding the Contest

In addition to the foregoing eight classifications, special prizes are awarded to those registering the highest net number of credit points during the period of the contest. Three of these prizes are for producers and three for non-producers, and the management has reserved the right to name the amount of these awards, so that the awards may be made in proportion to the amount of profit realized by the company during the period of the contest. Such things as committee work, athletic showing, handling and returning of tools, etc., are especially awarded or penalized, and also such things as department efficiency, department attendance, etc.

While this system should work out to the decided advantage of the employe as well as the employer, a strict discipline must also be maintained. No cheating or evasion of duty, if discovered, will escape being penalized, and second offences result in discharge. Payment of credits and special prizes is made immediately after the close of the contest.

In the case of a break occurring in a man's attendance record, efficiency rating, or any other feature of the contest, whereby from consecutive records cumulative awards accrue, the minimum point award then becomes the starting point for all additional awards. In general, where penalties are inflicted for breach of rules, the matter is handled in such a way as not to inflict undue hardship, and in most cases warnings are given before penalties are inflicted. These conditions, of course, are brought to the attention of the management and they are dealt with as the severity of the case warrants.

Effect of Contest on the Appearance of the Shop

The impressive thing about this contest is that it works, and the results are evidence that it has gone a long way toward bringing about the object for which it was designed. The interior of the shop presents an exceptionally attractive appearance and there is a noticeable freedom from congestion. The thought is evidently uppermost in each man's mind that a contest is in operation and that they are all after the big awards. Then as constant reminders, a number of notices are hung from the walls which read "Let's Keep Her Neat and Clean," referring, of course, to the machine and its environment. Whenever any complimentary correspondence is received from a customer commenting on the quality of the work produced or the promptness of shipment, or any other similar matter, the substance of such communications is made known to the men in the shop, if in the judgment of the management such a step will serve to encourage the men and enlist their cooperation.

* * *

FOREIGN TRADE FINANCING CORPORATION

At the meeting held in Chicago last December under the auspices of the American Bankers Association, which was attended by representatives of finance, industry, and agriculture, it was decided to form a Foreign Trade Financing Corporation with an authorized capital of $100,000,000 for the purpose of meeting the present critical situation with respect to the foreign trade of the United States. It is recognized that foreign buyers require longer credit than can be supplied under our present system, even when they are able to furnish adequate collateral securities. It is believed that the newly formed Foreign Trade Financing Corporation will result in increasing our export markets and will thereby encourage production. It is proposed that the extension of credit by the corporation shall be confined to countries where there is a stable government, and that the operations of the corporation should be confined to financing for the benefit of future foreign trade. The secretary of the committee on organization of the Foreign Trade Financing Corporation is William F. Collins, 5 Nassau St., New York City, from whom further information may be obtained by those interested.

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AMERICAN SOCIETY FOR STEEL TREATING

The American Society for Steel Treating, which has been formed by an amalgamation of the two former steel-treating societies with headquarters in Detroit and Chicago, has now settled down in permanent quarters at 4600 Prospect Ave., Cleveland, Ohio. The society is constantly increasing its membership, particularly through the action of the local sections or chapters. The first chapter to be established since the amalgamation of the steel-treating societies into the present organization was that in Syracuse, N. Y., where seventy-six applications for membership were presented at the opening meeting. The Philadelphia chapter is conducting a campaign to double its membership.

Production Planing in Machine Tool Plants

Methods Used in the Shops of Representative Engine Lathe Builders—Second of a Series of Articles

By EDWARD K. HAMMOND

PLANERS find extensive application in the shops of engine lathe builders, for use on such work as the machining of the ways of lathe beds; for planing the V-bearings in headstocks, carriages, and tailstocks, which fit the ways on the bed; for the planing of various slide bearings; and for the performance of numerous similar operations on the larger castings. In the first installment of this series of articles, mention was made of the fact that methods of production planing used by machine tool builders are probably as efficient as any that will be found in American machine shops, and this is particularly true of the work done in lathe-building plants. Manufacturers of this type of machine tool had for years been using methods that were well up to the average, but owing to the excessive demand for their product which arose during the war, production efficiency became so imperative that many methods formerly regarded as good enough were greatly improved to stimulate rates of output.

Planing Beds of 16-inch by 6-foot American Lathes

A typical example of the way in which quantity production methods have been applied in the performance of planing operations on lathe parts is shown in Fig. 1, which illustrates a 72- by 60-inch planer with a 40-foot table, built by the American Tool Works Co., Cincinnati, Ohio, and used in this company's plant for the performance of planing operations on American 16-inch by 6-foot lathe beds. Reference to this illustration will reveal the fact that there are twenty-four lathe beds set up on this planer at a time, the work being arranged in four parallel rows with six castings in each row. It will be seen that there are three heads on the cross-rail of the planer and two side-heads, all of which are frequently operated simultaneously. Such a procedure affords a possibility of attaining truly efficient results in the performance of production planing operations.

How the Work is Set up

Prior to the performance of the planing operation illustrated in Fig. 1, the lathe bed castings have been planed on their under side, which is used as a locating point. A better idea of the way that the castings are held on this planer will be gathered by reference to Fig. 2 which shows a close-up view of the tools and work. Here it will be seen that each casting is supported by two fixtures *A*, which are finished on their top surfaces to receive the previously planed under side of a lathe bed. Paper packings are used between the fixtures and the work, for the double purpose of providing a perfectly firm foundation and of accurately leveling up the work for planing. Each casting is held down by straps which secure a hold in the space on the inside of the lathe bed, so that they are not shown in the illustration; and each piece of work is lined up for planing by making measurements from the edge of the planer table. To prevent sidewise motion, planer table stops are placed inside of the work at each corner; and at the end of each of the four rows of lathe bed castings, larger sized stops are provided to support the thrust of the tools and to prevent endwise motion of the work. Between adjacent castings in each row, there are spacing blocks and sheet-metal packings which transmit the retaining force of the end stops.

Sequence in which Operations are Performed

The following outlines the sequence in which planing

In the quantity production of duplicate parts, jigs and fixtures are almost universally employed for the maintenance of dimensions within limits that assure interchangeability. Furthermore, the application of such means for locating successive pieces for machining makes possible the saving of a great deal of time in setting up work on the machines. In planing operations, however, it is quite a general practice to set the work directly on the platen, dependence being placed upon the skill of the planer-hand to set up his job in such a way that the required degree of accuracy will be secured. In handling heavy work, it frequently happens that the weight of the piece to be planed and various other considerations prevent the employing of a work-holding fixture. Hence some users of planers seem to believe that it is not practicable to use fixtures on the planer; but this is not the case, and in this article a number of good examples are shown of the use of fixtures that locate the work without calling for as much care from the planer-hand as would otherwise be required, and that also save a great deal of time.

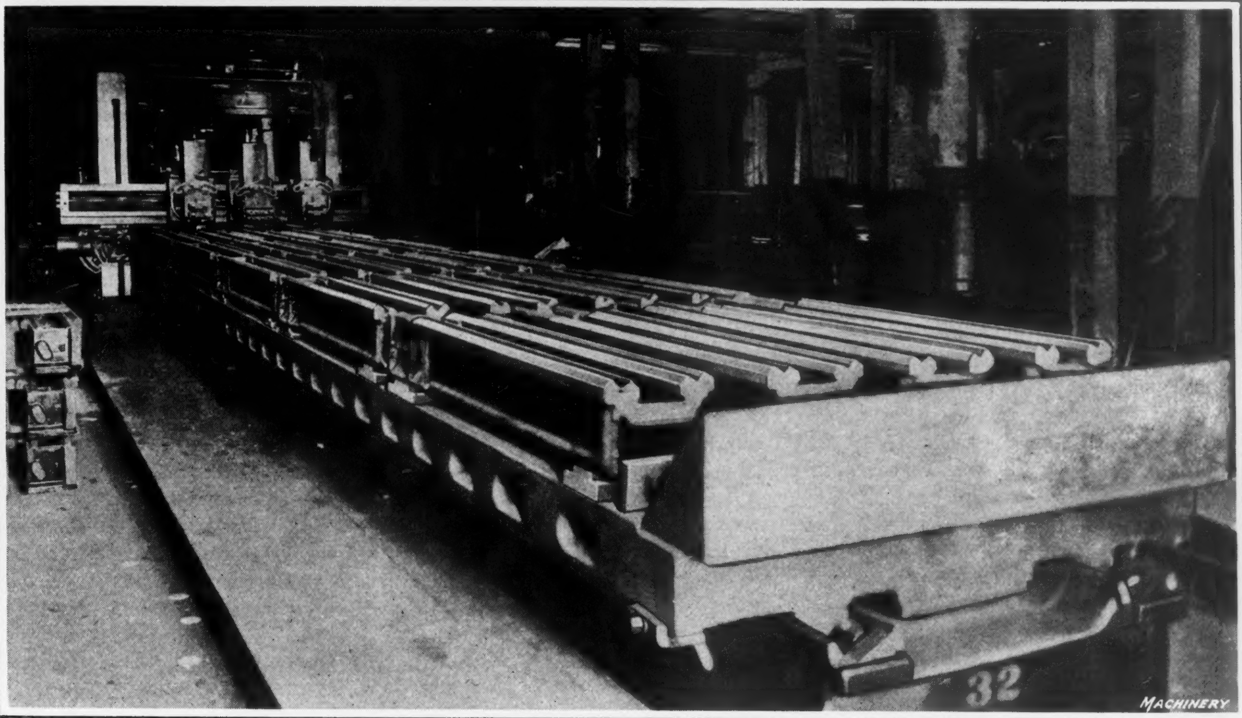


Fig. 1. Planer equipped for simultaneously planing Twenty-four 16-inch by 6-foot Lathe Beds

operations are performed on these lathe bed castings: A roughing cut is first taken on the tops of the V-bearings with multiple tool-holders in the rail-heads, carrying round-nosed cutter bits, as shown at *B* in Fig. 2, which provide for working simultaneously on three faces of the work. Next, a tool-holder carrying two round-nosed cutter bits is set up in each of the two outside rail-heads to provide for taking a roughing cut in the spaces between two V-bearings. With these tools, two rows of castings are first planed, and then the rail-heads are set over to plane the other two rows. Then the tops of the V-bearings are spotted ready for subsequent work which is to be performed on their angular sides, this cut being taken with square-nosed tools of 3/16-inch face width carried by the rail-heads.

For taking a roughing cut on the inclined sides of the V-bearings, use is made of round-nosed tools held in the rail-heads which are set at an angle, so that the feed movement of the heads can be utilized to run these tools down the sides of the work. Next, a roughing cut is taken on the vertical sides of the lathe bed adjacent to the V-bearings, using a tool-holder carrying twin round-nosed cutter bits in each of the rail-heads, and a single tool-holder in each of the side-heads. In this way, the twin tools carried by the rail-heads simultaneously plane the sides of adjacent castings, while the tools carried by the two side-heads plane the remaining outer sides of the castings in the outside rows.

For rough-planing the under-cut below the V-bearings, use is made of tool-holders of the form shown at *D*, which are carried by the rail-heads, each of these holders having its cutter bit extending out sidewise, so that it can reach under the shoulder below the V-bearing and plane this face of the work. In performing the present operation, a roughing cut is taken on the outside of the castings, while roughing and finishing cuts are taken on the inside. The tools used for this purpose have a spring relief for the cutter bit, which acts in a manner similar to the clapper-box of a planer, thus allowing the tools to relieve themselves during the return stroke of the planer table.

Next in the order of planing operations on these lathe bed castings comes the finish-planing of the tops of the V-bearings with square-nosed gooseneck tools in the rail-heads, and then the rough-planing of horizontal pads that are provided between the bearings at the head end of the lathe, two round-nosed tools being used in the rail-heads to plane the first two rows of castings and then the other two rows. The next step is to take a "straightening out" cut on the V-bearings, using shearing tools that extend across the face of the work and take a cut of from 0.002 to 0.004 inch in depth. One of these tools is shown at *I*, where it will be seen that it is of the so-called spring type, so that there is no danger of the cutting edge digging into the work. The forging is done in such a way that the cutting edge of the tool extends right across the surface of the work to be planed, and this edge is set at an angle to the line of travel of the work on which it is operating, so that a shearing action is obtained which leaves a good smooth finish. These tools are carried by the rail-heads.

There is a vertical slot to be planed in each casting, and this is done with square-nosed tools of the required width, which are carried by the rail-heads and fed straight down into the work. Then comes the planing of a clearance angle between the vees with square-nosed tools in the rail-heads; and after this has been accomplished the vees are finish-planed with gooseneck tool-holders having V-shaped cutter bits that simultaneously plane the entire surface of a vee and thus assure the accuracy of its form.

Following the performance of this operation comes the finish-planing of vertical surfaces on the inside and outside of the lathe beds, using shearing tools or so-called "side finishing" tools of the type which have a cutting edge of sufficient width to extend over the entire surface to be planed, so that they are able to take a light shearing cut which gives a very fine finish. These tools are carried by the rail-heads. The pads between the vees at the head end of each lathe bed are next finish-planed with square-nosed tools in the rail-heads, after which the under-cuts beneath the dovetail bearings are finish-planed with shearing tools carried by swivel tool-holders in the rail-heads, these tools being of the same kind that were used for performing the roughing operation. Finally, the tops of the vees are rounded with formed tools carried in the rail-heads.

Earlier in this discussion of the sequence of operations performed on these lathe bed castings, statements were made concerning the way in which either two or three of the rail-heads are used at the same time; also, it was learned that in certain cases, all three of the rail-heads and the two side-heads are operated simultaneously. In each case, it is the desire to have the greatest possible number of tools at work, the procedure always being governed by the number of surfaces to be planed on four rows of lathe bed castings and by

the locations of these surfaces. For instance, in planing the vertical sides of the lathe bed castings adjacent to the vees, it was possible to operate all three rail-heads and the two side-heads simultaneously, because twin tools in the rail-heads were utilized to engage the three pairs of sides between adjacent rows of castings, while single-point tools carried by the two side-heads plane the outer sides of the two outside rows of castings. In this way, provision is made for simultaneously planing both sides of the castings in all four rows.

On the other hand, rough-planing of the pads located between the ways at the head end of the lathe beds, is done with single tools carried by two rail-heads, the procedure being to first plane the pads in two rows of castings and then to set the heads over on the rail to plane the pads on castings in the other two rows. Evidently, there would be no advantage in using three rail-heads on this job, as one head would subsequently have to be set over to plane the pads in the fourth row of castings. This general discussion of the procedure followed in performing two typical operations should enable the reader to understand how the tools are distributed for taking other cuts on these castings, without requiring further description of the set-up.

Reference to Fig. 2 will convince any experienced planer-hand that the tools which have been developed for the performance of these planing operations have been carefully designed with a view to expediting production. Little thought need be given to this subject to realize that with multiple tool-holders of the types which are shown set up in the planer heads or lying on the work, and with provision for having as many as five tools operating simultaneously, very satisfactory rates of output can be realized. Doubtless there are many planer-hands who have not had occasion to use formed tools for such work as finish-planing dovetailed bearings. Such tools can be used with very satisfactory results for the planing of work that is required to have two or more surfaces finished in definite relationship to each other. The principle involved in the design of these tools is really nothing more than the reversal of one that is commonly used in dovetail finishing tools, which are fed into the work to plane the inclined side and bottom faces of the bearing. It will be apparent that the principle of the V-bearing finish-planing tool is identical, except that in the present case the tool embraces both sides of the work, instead of having the work encompass two sides of the tool.

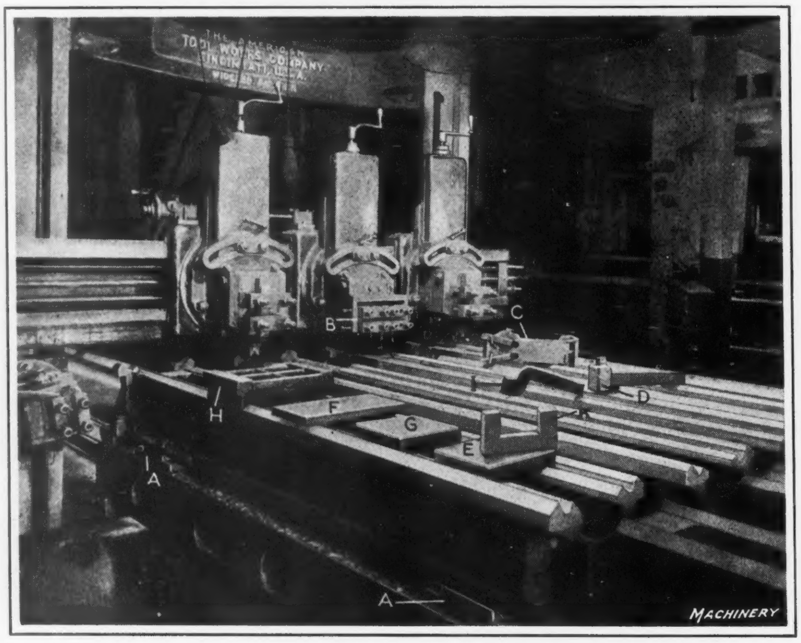


Fig. 2. Close-up View of Tools and Work on the Machine shown in Fig. 1. Attention is called to the Fact that Various Tools are shown set up for Purposes of Illustration; actually, these Tools are used in Sequence

Gages for Testing Accuracy of the Finish-planed Lathe Beds

In the preceding discussion, emphasis was laid on the fact that the tooling up of this planer has been worked out along lines which expedite rates of output. But it is also required to hold finish-planed faces within close limits of tolerance, and in Fig. 2 there are shown gages employed for testing the accuracy of the finished product. Gage *E* is furnished with two inclined parallel gaging faces which contact with corresponding sides of the V-bearings at opposite sides of a lathe bed, to provide for measuring the spacing between these bearings. This gage is used in conjunction with tissue paper feelers that are cut in strips measuring about 1/4 inch wide by 2 inches in length. Two of these strips are placed at the top and bottom of each V-bearing to be tested, and with the papers in these positions, the gage is required to hold all four of them in place. Thus it constitutes a test for both the alignment and inclination of the sides of the bearings, and if any of the four tissue papers is not firmly held in place under the gage, it indicates an error exceeding 0.001 inch, and such a lathe bed will have to be replaned until the test can be conducted with satisfactory results. Gage *E* is used for testing each side of the two inner V-bearings, and a gage *F* of identical design provides for conducting similar tests on the outer pair of V-bearings.

Two other gages *G* and *H* are used, respectively, for testing the bearing of the inner and outer pairs of vees on the work. For this purpose the bearings on the gages are rubbed with crayon or red lead, and the excess material is removed, after which gage *G* or *H* is put in place and rubbed along the work in order to ascertain whether a uniform contact is secured at all points. Gages *G* and *H* have on their under sides two gaging points which duplicate the contact of the bearings on the lathe headstock, carriage, or tailstock; that is to say, the fixed points on these gages which contact with the work correspond to the bearings which will subsequently rest on the vees. If the ways on the lathe bed contact uniformly with these gages, satisfactory results will be obtained when accurately planed headstocks, tailstocks, and carriages are assembled on these beds. A snap gage *K* is used for testing the width from the inner to the outer vertical face of each pair of V-bearings planed.

Setting up Large Lathe Beds on Planer

Bearing in mind the wide range of sizes in which lathes are built, it will be apparent that methods of planing the bed castings must be substantially modified to meet the requirements of different sizes of work. This fact is well brought out by a comparison of Figs. 1 and 3, the latter illustration showing the set-up of a planer built by the G. A. Gray Co., Cincinnati, Ohio, which is used in the plant of the Lodge & Shipley Machine Tool Co., in Cincinnati, for the performance of planing operations on the bed of a 48-inch engine lathe. In handling large heavy castings of this kind, it is not found practical to set up more than one at a time; and owing to the great length and weight of the work, care must be taken to support it in such a way that there will be no distortion to subsequently affect the accuracy of the results obtained in planing.

So far as the actual performance of successive operations in the planing of large lathe beds of this kind is concerned, there is no point that differs sufficiently from the methods covered by the previous description to call for further discussion. In the present case we are interested merely in the setting up of the casting for planing. As it is delivered from the foundry to the machine shop, each casting first has its under side planed, and this face is then available as a locating point in setting up the casting for subsequent planing operations that have to be performed. Three parallel blocks are first placed on the planer table, in such positions that

two will come under the corners at one end of the casting and one will come under the center of the opposite end of the casting as it is lowered to the planer table. The casting is then lined up from the edge of the planer table. Next in the method of procedure in handling this job comes the laying off on the end of the work nearest to the planer cross-rail the various surfaces that have to be machined on the lathe bed casting, so that prior to the starting of any cuts, assurance is obtained that not only will all surfaces clean up properly, but that they will also be centrally located relative to the side walls of the casting.

After this point has been reached, the procedure in setting up becomes distinctly different for a long heavy lathe bed than it is for a short piece of work which is not of sufficient weight to cause a serious amount of sag at the center. Despite a somewhat general impression that large pieces of iron or other metal are quite rigid, a carefully conducted investigation of such a set-up as the lathe bed now under discussion would reveal the fact that there is a very appreciable amount of sag at the center. To overcome this distortion, a practice is made of slightly raising the casting and placing parallel blocks at each side of the work at the center, and then at various points along each side between these center blocks and those which were first placed under the end of the work.

Next comes the placing of packing papers between the blocks and the work, their purpose being to assure a perfectly uniform and solid foundation. After an equal number of papers have been placed between each block and the work, the planer-hand proceeds to use what is known as a "pinch-bar," shown at *A* in Fig. 3, with which he is able to pry up the casting at a point adjacent to each block and test the degree of tension with which the packing papers are held between the block and work, for a given amount of pressure applied at the outer end of the pinch-bar. The planer-hand applies pressure on the end of the pinch-bar with his right hand and tests the packing papers with his left. Following this procedure he adds or removes packing papers from between the various blocks and the work until a condition has been reached where the papers are held with a uniform tension on each block. This assures that the casting is uniformly supported at all points and that there are no points where the casting has sagged down sufficiently to cause a serious amount of distortion, which will subsequently affect the accuracy of the work.

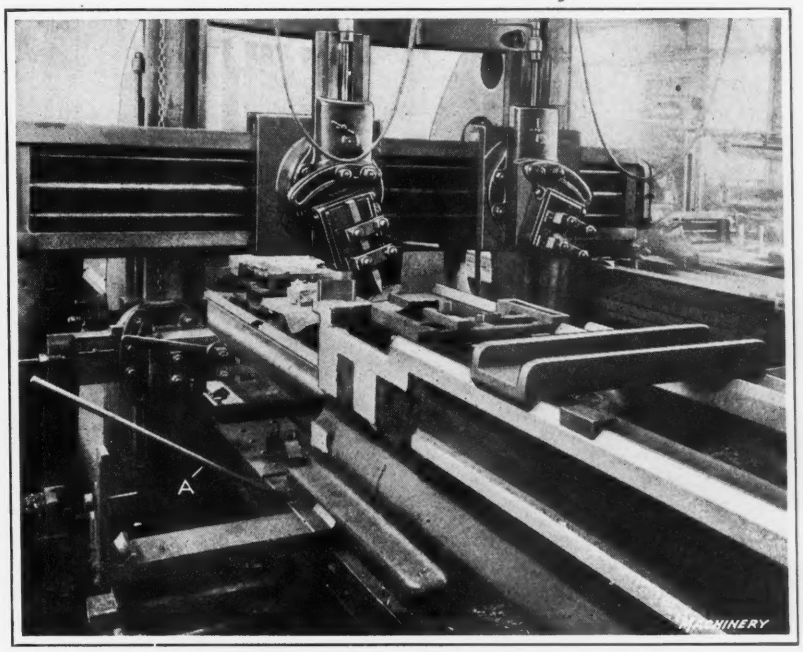


Fig. 3. Close-up View of a Large Lathe Bed that is being planed, showing Method of setting up and Gages for testing Finished Work

Planing Headstock Castings of Lodge & Shipley Lathes

In the title illustration of this article, there is shown a 54- by 54-inch widened pattern G. A. Gray planer with a 30-foot table, on which twenty-two headstock castings for 20-inch Lodge & Shipley lathes are set up for the performance of planing operations on these pieces; and lying beside the machine there is shown another lot of castings which have been delivered so that they are ready to be set up as soon as the machining of the previous load of pieces has been completed. A more definite idea of the way in which these castings are held for planing will be gathered from Fig. 4 which shows a close-up view of four of the castings and of one of the setting-up fixtures that are used in connection with this job. As all experienced planer-hands know, it is quite a general practice to set the work directly on a planer table or in very simple forms of holding fixtures that are of little or no assistance in locating the castings, and it is for this reason that a considerable amount of skill and judgment is often required of the planer-hand in setting up his work, before the actual machining operations are commenced.

Use of Fixtures to Facilitate Setting up the Work

A noteworthy feature of the present job, and of the equipment of this machine, consists of the provision of work-holding fixtures that relieve the operator of much of the responsibility ordinarily connected with the setting up of planer work. These fixtures also enable the work to be set up far more rapidly, thus expediting rates of output. The setting up of this job is more like the procedure followed in loading work on a milling machine, or on one of the other types of machine tools commonly used for the quantity production of duplicate parts. Only through the use of such means can the planer attain its maximum rate of output.

Fig. 4 illustrates the Lodge & Shipley headstocks held ready for performing the first planing operation, and the method of setting them up in the fixtures is as follows: The castings are lowered into place on the heads of three adjustable screws which engage the under side of the work. In addition to the work-holding fixtures that are shown in place on the planer table, one fixture *A* is illustrated lying unloaded at the end of the machine, in order to more clearly show its design; and at *B* there is illustrated one of a pair of locating arms that are employed in setting up the work. Reference to this illustration will make it apparent that cut in the right-hand vertical side of the work-holding fixture there is a T-slot which serves the double purpose of receiving a locating tongue carried by the bracket on arm *B* that rests on the side of the fixture, and also of holding the head of a bolt by means of which the locating arm is clamped in place on the fixture. The nut which fits over this bolt is in the form of a handwheel *C*, so that after the arm *B* has been slipped over the bolt with its tongue in the groove in the fixture, wheel *C* is screwed on the bolt to provide for clamping the arm in place.

At the top of arm *B* there is a bell D_1 which fits over one of the back-shaft bearing bosses D_2 on the work. It will be seen that two adjacent work-holding fixtures *A* support the opposite ends of a headstock casting, and the method of procedure in setting up the work is to secure two locating arms *B* to these two adjacent work-holding fixtures, so that the bells D_1 on these two arms can receive the two back-shaft bearing bosses D_2 on the casting and afford a temporary means of support. As the casting is hung in the bells on these arms, it swings downward until further movement is checked by having its side wall come into contact with stop *E* provided inside of the fixture for that purpose. Then two

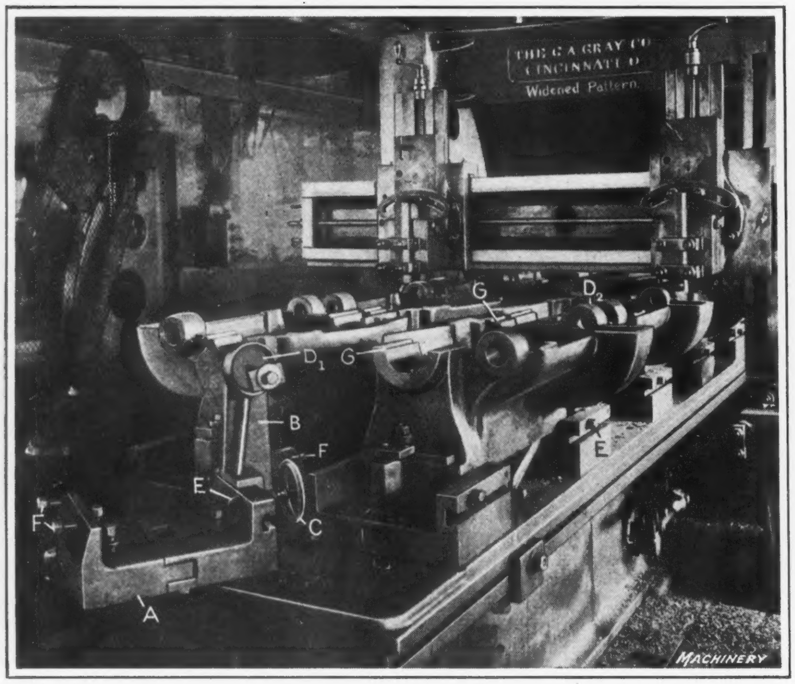


Fig. 4. Close-up View of Lathe Headstock Castings and Planer Tools. The Entire Set-up for this Job is shown in the Heading Illustration

screws *F* at the opposite side of the fixture are tightened in order to hold the work securely against sidewise movement, after which the three adjustable screws under the work are raised until they come into contact with the bottom of the casting.

With the work located and held in this manner, the two locating arms *B* can be removed and employed in setting up the next casting of the string, this method of procedure being continued until all of the twenty-two castings have been set up in two parallel rows. It will be evident from the illustration that two castings in the two rows are reversed end for end, so that the back-shaft bearing bosses are at the outside of the row in each case. After all of the castings have been located in this way, they are clamped down with the familiar form of straps held by bolts in the planer table T-slots, and then jacks are put between adjacent castings in each row to support the work against the end thrust of the tools. Finally, large jacks are placed at the end of each row of castings to support the entire thrust load.

Sequence of Planing Operations

Planing operations to be performed on these castings consist of finishing the two fits *G* for the spindle bearing caps and the fit for the joint between the headstock cover and the main part of the casting, which is the piece shown in process of planing in Fig. 4. On these operations three cuts are taken, namely, a roughing, a straightening out, and a finishing cut, the roughing cut being taken with a round-nosed tool, while square-nosed tools are used for straightening out and finishing. All three operations are performed at a cutting speed of 55 feet per minute, with a feed of 1/16 inch for roughing, and hand feed for straightening out and finishing, varying from ½ to 1 inch according to the position at which the tool is working.

In taking the roughing cut, about 0.020 inch of surplus metal is left, of which 0.015 inch is removed by the straightening out cut and 0.005 inch by the final finishing operation. A high degree of accuracy is not required, except on the seats for the spindle bearing caps, and after the finish-planing operation has been performed on these fits *G*, the work is tested with "Go" and "Not Go" gages that call for accuracy within 0.002 inch. The same equipment is used for planing various sizes of Lodge & Shipley lathe headstock castings, but it is necessary to have special locating arms *B* for each size of work. For the 20-inch lathe headstock castings which are shown, the production time for setting up and planing twenty-two castings is eight hours. On the smallest sizes, it is possible to set up twenty-six pieces of work, while only fourteen of the largest sized headstock castings can be set up on the planer table at a time.

Planing Base of Tops for Lathe Tailstocks

One type of tailstock used on Lodge & Shipley lathes has a lower member that is secured to the ways on the bed of the machine and a top member which is located on the lower portion of the tailstock by means of a tongue and groove joint. Fig. 5 shows a 36- by 36-inch extra heavy pattern G. A. Gray planer with a 24-foot bed, which is equipped for holding a string of eighteen of the upper tailstock members for 18-inch lathes while the base and tongue joint are being planed on these pieces. This set-up represents another example of the possibilities of tooling up a planer for performing repetition work, in such a way that the fixtures relieve the operator of a large part of the responsibility of obtaining accurate settings. In the present instance, the method of locating the work is as follows: Fig. 5 shows a fixture that provides for holding three castings, and six of these fixtures are set end to end along the planer table to hold eighteen pieces of work.

Each casting *A* is inverted and held in place in the fixture by the spindle bearing bosses that are dropped into V-blocks *B*, after which the casting is swung backward so that it rests against a bracket *C*; then a screw carried by the corresponding bracket in the next section of the fixture at the front of the casting is tightened up, to hold the work firmly in place against this locating point. Finally, two screws *D* are tightened on the top of the spindle bearing boss at each side of the fixture, to hold the work against any tendency toward lifting. In order to locate successive pieces of work in this manner, the method of procedure that is followed consists of setting up the casting nearest the cross-rail and

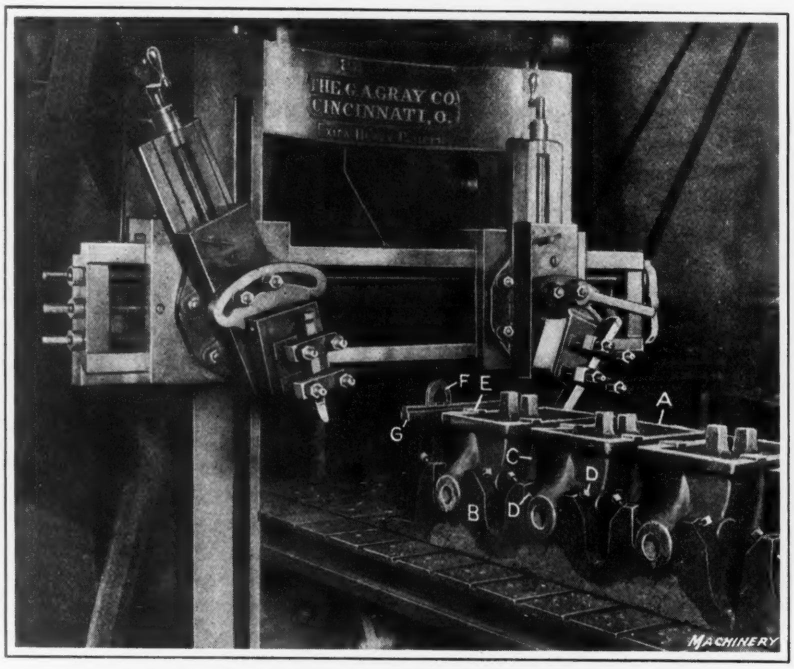


Fig. 5. Close-up View of Tools and Work on Machine used for planing Base of Top Castings for Lathe Tailstocks

working to the opposite end of the row of fixtures, in order that there may be plenty of room for tightening up the screws to locate the work securely in place against the brackets *C* on the string of fixtures.

Planing Operations to be Performed

So far as the actual planing is concerned, this is quite a simple operation, consisting of merely planing the flat lower face of the tailstock castings and the tongue which locates the upper casting on the base of the lathe tailstock, in which a corresponding groove has been machined. The usual sequence of round- and square-nosed tools is utilized for the performance of roughing, straightening out, and finishing operations on these castings, this work being done at a cutting speed of 55 feet per minute for all operations, with a feed of 1/16 inch for roughing, and hand feed for straightening out and finishing at the rate of from ½ to 1 inch according to the location. The straightening out cut removes about 0.015 inch of metal, leaving 0.005 inch for the final cut.

Prior to taking the straightening out and finishing cuts, a practice is made of loosening the four clamping screws *D* and the screw which holds each piece of work back against locating bracket *C*, so that the work may be reset to remove any strains which may have been produced by the pressure of these screws. In resetting for taking the two final cuts, the screws need not be tightened to the same extent that was necessary for holding the work for taking the heavy roughing cut. This is an important point in improving the accuracy that is obtained in the performance of planing operations of this general character. The only part of the work that has to be finished to a high degree of precision is the tongue *E* which must be finished within 0.001 inch of the specified size. For checking the accuracy of this part of the work, a snap gage *F* is used. A master form *G* is provided to facilitate the setting of the tools; and the work-holding fixtures are located by tongues on their under side that enter the T-slots in the planer table. On this job the time required to complete the planing operation on eighteen of the tailstock castings is from six to seven hours.

Planing Carriages for 14-inch American Engine Lathes

Fig. 6 shows the use of a 60- by 48-inch American planer with a 26-foot table, which is used in the American Tool Works Co.'s plant, for planing the carriages for 14-inch lathes of this firm's manufacture. Thirty castings are set up on the machine in two parallel rows, and the end casting of each row is carefully lined up and located in that position by means of stops, after which parallel packings are placed between adjacent castings in the row, thus obtaining their approximate location from the setting of the first piece in each row. Tests of the setting of each casting are then made, and paper packings are used to supplement the spacing blocks in order to have each piece of work accurately located. Also, it is necessary to test from the bottom of the casting to the top, using a surface gage to make this measurement from the planer table, in order to be sure that each casting will clean up properly. After the work has been set up and tested in this manner, straps *A* are used to hold the castings down.

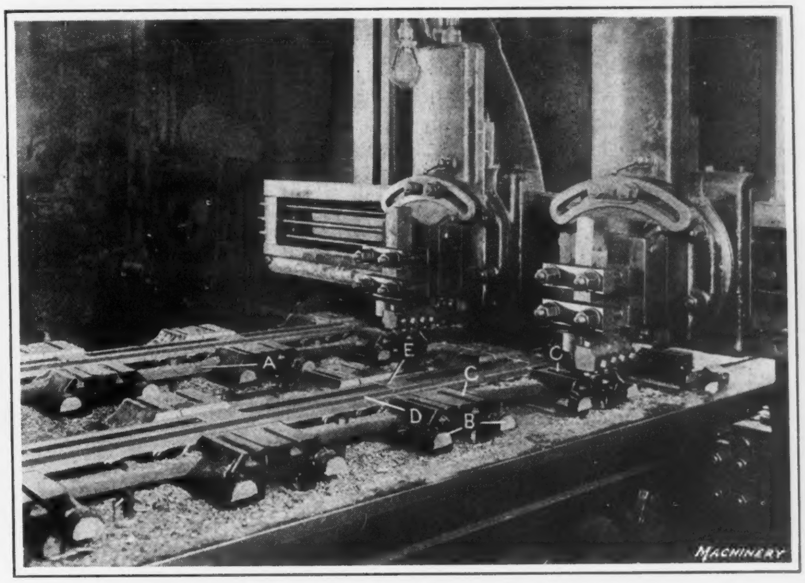


Fig. 6. Application of Multiple-cutter Tool-holders for performing Planing Operations on Lathe Carriages

The sequence of operations performed on these pieces of work consists of planing the ends *B* of the dovetail bearings, faces *C*, dovetail *D*, and clearance face *E*. On each surface, one roughing cut and one or more finishing cuts are taken, it being required to finish the work within a tolerance of 0.0005 inch. All roughing cuts are taken at a speed of 45 feet per minute, with a feed of ⅛ inch at the ends of bearings *B*, ½ inch on faces *C* and *E*, and 1/32 inch on dovetail *D*. For taking the finishing cuts, the same speed is employed with a feed of ½ inch at *B*, ¾ inch at *C*, ⅜ inch at *D*, and a shearing cut over the full width of face *E*. The production time for planing thirty of these castings is approximately thirty-two hours.

Fig. 6 shows the work of rough-planing surface *C* of the castings with a gang tool-holder made by the Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. It will be seen that two rail-heads are in use, with one of these tool-holders in each head, thus providing for simultaneous operation on both rows of castings. Each of these tool-holders is furnished with four cutter bits which are staggered, so that they reach over a considerable width, the bits being set to take a progressively deeper cut from right to left. In this way they divide up the depth of chip, thus relieving the severity of the service required of the planer tool and removing from the work-holding clamps a substantial part of the load which they would otherwise be called upon to carry. The familiar types of round-nosed roughing tools, square-nosed finishing tools, and dovetail planing tools are used for the other operations on the castings.

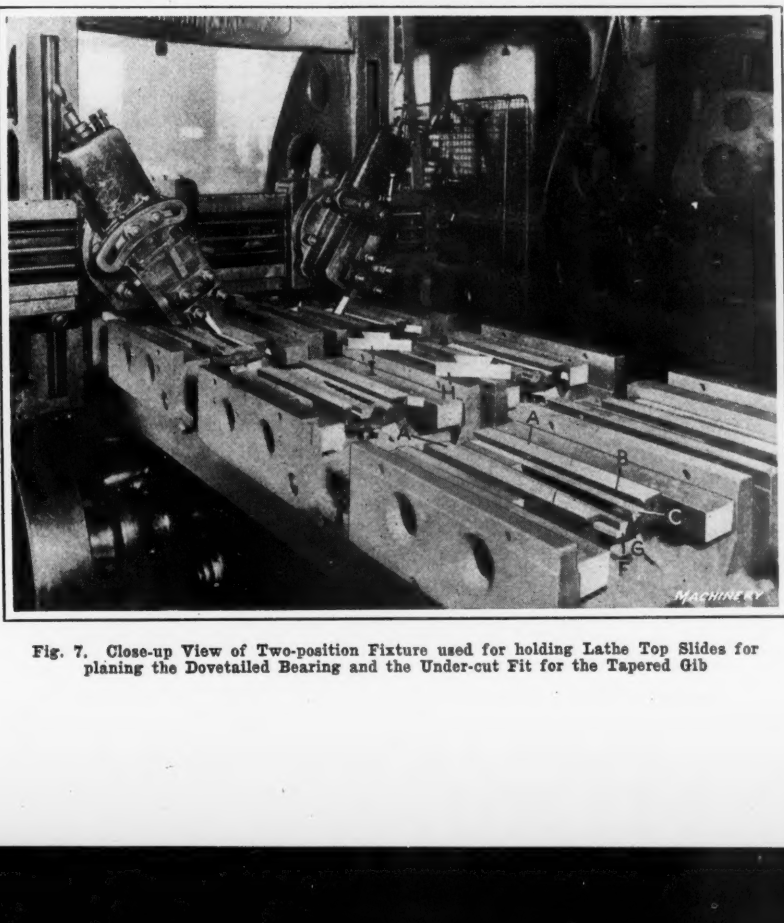


Fig. 7. Close-up View of Two-position Fixture used for holding Lathe Top Slides for planing the Dovetailed Bearing and the Under-cut Fit for the Tapered Gib

Planing Under Side of Top Slides for 18-inch American Engine Lathes

A planing operation is illustrated in Fig. 7 which is of interest for two reasons: First, because it constitutes a good example of the degree of accuracy that can be attained in the performance of planing operations, and second, because the design of the work-holding fixtures has been developed along lines which afford a convenient means of planing one surface at a specified taper angle to another face of the work. The machine is an American 36- by 36-inch by 18-foot planer, and it is shown in operation in the American Tool Works Co.'s plant, planing the top slides for 18-inch lathes of this firm's manufacture. With this general statement as an introduction, we are in a position to enter upon a detailed description of the way in which successive planing operations are performed.

As the castings come to this machine, they have been milled on what is normally their top side, although this milled surface constitutes the base on which these pieces are held in the planer fixtures; also, the edges of the castings have been finish-planed. Each of these castings is supported in its fixture on the previously milled under side, after which clamps engage the finished side faces of the work and secure it firmly in place. In order to assure uniform support, paper packings are used as explained in connection with set-ups previously described. As held in the present fixture, the operation consists of planing on each casting two horizontal faces *A*, the inclined side *B* of the dovetailed bearing which is parallel to the previously planed edges of the work, two faces (one of which is shown at *C*) at the bottom of the dovetailed bearing, and the edge *D* of the opening for the dovetailed bearing, which is inclined at a taper angle to the edges of the work that were previously planed.

Fig. 8. Another Arrangement of a Planer for planing Lathe Top Slides and the Tapered Gibs that fit into these Slides

Planing an Under-cut to Receive a Tongue on the Gib

Next in the order of operations comes the planing of an under-cut *E* which is located at an angle to receive the tongue on gib *F*. It is the fit between the under-cut *E* and the tongue on gib *F* that constitutes an example of the accuracy that can be obtained in the performance of planing operations, provided the necessary care is taken in handling the work. The method of procedure in planing these top slide castings is to drive the previously planed tongue on the gib into the groove *E*, and then depend upon the fit between these two members to hold the gib in place, so that one side of a dovetailed bearing can be planed on it, parallel to the side *B* that has already been finished. The order in which these operations are performed is important. First, faces *A*, *B*, and *C* are planed; and then the clamping bolts are loosened and the fixture is swiveled on its pivotal support to a second position which inclines the work at an angle to its previous setting that is equal to the angle that it is required to finish on the work, after which the clamping bolts are tightened and edge *D* and under-cut *E* are rough- and finish-planed.

Driving the Gib Tongue into the Groove Planed in the Slide

As they are delivered to this planer, the gibs have had the tongue planed on them, so that they are ready to be driven into place in the top slide in the manner shown in Fig. 7. When this has been done, the work-holding fixtures are once more swiveled back to their normal positions, after which the top surface of gib *F* is rough-planed. Then scaling from the finish-planed edges of the work, the sides of the dovetailed bearing are accurately laid out and side *G* of the bearing is rough-planed, after which the top surface of gib *F* is finish-planed, and finally the sides *B* and *G* of the bearing are finish-planed. In this way the two inclined sides *B* and *G* of the dovetailed bearing are planed parallel, while the fit of the gib in the slide is tapered, so that longitudinal movement of the gib will result in affording the familiar adjustment of the fit of the slide.

Referring again to the design of the work-holding fixture, attention is called to the fact that each fixture is carried by a pivotal support and furnished with adjusting screws that provide for swinging each fixture about its pivot to engage either of two locating stops which set the fixture and work carried by it to provide for planing either of the two sets of surfaces on the castings that are to be finished at specified angles to each other. There are eighteen of these fixtures set up on the planer table in two rows containing nine fixtures each.

Finish-planing operations are performed on the two inclined sides of each dovetailed bearing until it fits the sheet metal templet *H*, and finally the form of the bearing is tested with a block gage *I* that is used with red lead. In performing the planing operations on these parts, dimensions must be held within a tolerance of 0.0005 inch in the dovetailed bearing, and the operations are performed in the following manner: Roughing cuts are taken at a speed of 60 feet per minute, with a feed of 1/16 inch on all faces except the inclined sides of the dovetail, where a feed of 0.006 inch is employed. For finishing, the same speed is used with a feed of 3/8 inch on all faces except the inclined sides of the dovetail, where hand feed is utilized. In taking the roughing cut, 0.030 inch of metal is allowed for subsequent finishing cuts that may be required, in order to bring the bearing to a fit on the gage *I*. The production time on this job is eighteen and three-quarter hours for planing eighteen castings.

Comparison of Practice in Planing the Under Side of Lathe Top Slides

It is always interesting to compare the methods used in different shops for the performance of the same machining operation, and an opportunity of so doing is presented by the jobs illustrated in Figs. 7 and 8. Of these, the former shows methods used by the American Tool Works Co., for planing the under side of top slides for engine lathes, and in Fig. 8 there is illustrated the equipment of a G. A. Gray planer used at the plant of the Lodge & Shipley Machine Tool Co. for performing the same operation. In so far as

the method of planing the tapered fit for the gib is concerned, the procedure is the same in both cases.

Also both shops plane the dovetailed side of the gib after the tongue has been driven into the under-cut planed in the slide casting for that purpose. It is in the methods of setting up the work to obtain the required locations for performing successive operations that the methods of these two machine tool building plants are different; and this is where the interesting comparison comes in.

Equipment of a Single Planer for Handling Two Production Jobs

In the present case it will be seen that thirty-eight top slide castings for Lodge & Shipley lathes are set up in two parallel rows, but at the outset attention is called to the fact that the practice in equipping this planer differs from that of the case shown in Fig. 7, because the same machine is provided with means for planing both the top slide and the fit on the gib that enters the groove planed in the top slide for that purpose. At the time that the gibs are being planed, thirty-eight of these castings are set up on the machine in two parallel rows, the method of making this setting being shown at *D* in Fig. 8, where one gib has been put in place in order that the procedure which is followed may be readily understood.

Secured to the planer table, it will be seen that there are three parallel strips *A*, *B*, and *C*. Strips *A* and *B* are utilized as locating points against which either the gib castings or the top slide castings are located, while thrust members for holding the top slides against these strips are abutted against the left-hand sides of strips *B* and *C*, respectively. For holding the gib castings *D* in place, it will be seen that similar clamping members are provided, except that the pressure for holding the work is secured by means of stops *E* which are located in the table T-slots and furnished with thrust screws. The gibs are held edgewise, so that the fit and tongue for anchoring the gib in the top slide may be planed. One of the gib castings is shown standing crosswise on the planer table, where it will be seen that two legs *F* are cast on each gib, these legs being utilized as points against which the clamps grip the work. After the planing operation has been completed, these legs are broken off the gibs so that they may be assembled into the top slide ready for planing the dovetailed bearing on the side of the gib from which the legs were broken off.

Pivoted Work-holding Fixture versus Tapered Setting Strip

It will be recalled that according to the method of procedure followed in planing top slides for American lathes, each work-holding fixture was supported on a pivot and arranged with two limit stops that controlled the distance that it could be swung in either direction. In this way the work could be held in one position for planing the straight sides, after which the clamping screws were released and the fixture swung to its other extreme position, in order to locate the casting for planing the tapered fit for the gib. With the method of setting up this job in the Lodge & Shipley plant, a tapered bar is inserted between each piece of work and the parallel strips *A* and *B* to locate the work for taper planing. As these bars have the same angle as the tapered fit that it is required to plane in the top slide castings to receive the gibs, it will be apparent that the work will be planed to the required form.

As the top slide castings are delivered to this machine, they have been planed on what is normally the top, and the edges have also been planed. The order in which operations are performed is as follows: First, the castings are clamped against the tapered bars placed between the work and the locating strips *A* and *B* on the planer table, after which the fit is planed to receive the planed tongue on the gib. After this result has been accomplished, the gibs are driven into place and the work reset directly in contact with strips *A* and *B*. Then the dovetailed side of the gib is planed and also the dovetail on the opposite side. The other planing operations are performed at this setting. To obtain the required accuracy in setting the work, paper packings are used between the locating points on the planer table and the previously finished sides of the castings. For planing the fit on the gibs, it will be evident that only one setting of the work is required. After the description of planing operations performed on the job shown in Fig. 7, a detailed description of the sequence of cuts is unnecessary; but it may be mentioned that the dimensions are held within a tolerance of 0.0005 inch.

* * *

SAND-BLASTING WORK BEFORE GRINDING

Oxide scale produced on the surface of castings or forgings is considerably harder than the body of the metal; and where parts covered with such a scale have to be machined, the cutting tools are likely to become dull after only a short period of service. To overcome this difficulty it is quite a general practice to resort to the use of a sand-blasting machine for removing the scale; but it is probable that few mechanics have heard of using the same method of preparing work in which the inside of small openings has to be ground. This method has been adopted in the National Acme Co.'s plant in Cleveland, Ohio, for preparing raceways for ball and roller bearings that are to have the bore ground on internal grinding machines. After being machined, these pieces are subjected to a process of heat-treatment to give the desired physical properties to the steel, and the sand-blasting operation is next performed to remove the oxide scale produced on the work while in the furnace.

At the time when a decision was reached to sand-blast these pieces before grinding, the primary object was to effect an increase in the rate of production, and subsequent experience has shown that this increase amounts to fully 50 per cent, as compared with the time required for grinding raceways that have not been sand-blasted. Small grinding wheels used for precision internal grinding operations are more delicate and more likely to become "glazed" than larger sized wheels. If an attempt is made to grind work that is covered with a hard oxide scale, it is found that the grinding wheel requires dressing with a diamond at frequent intervals in order to remove the glazed surface which is no longer capable of cutting efficiently; and for that reason the removal of the scale from the work that is to be ground with such wheels becomes a matter of unusual importance.

It has already been stated that the rate of production has been increased 50 per cent by a preliminary sand-blasting operation. This saving is due to the fact that it is unnecessary to stop work as often in order to dress the wheel, and as a result the grinding machine is able to operate for longer periods without interruption. Another important saving resulting from the sand-blasting operation is that the working life of each wheel, that is, the amount of service obtained before the wheel is worn out, is substantially increased. Average results show that at least double the amount of service is obtained from each wheel where it starts work on the clean metal surface without being required to first remove a hard outer layer of iron oxide scale.

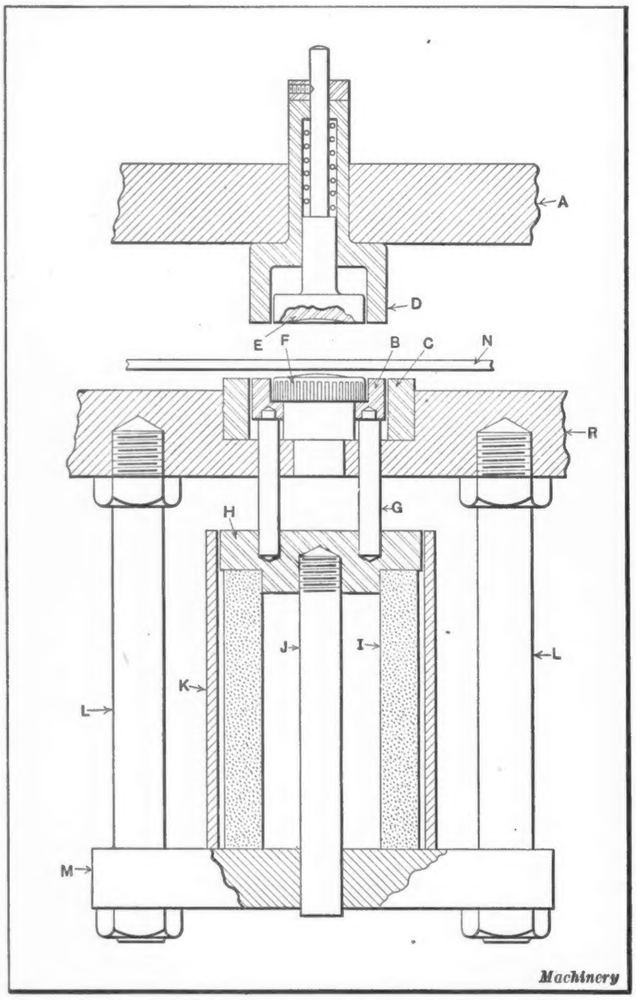
* * *

SWISS MACHINE TOOL REQUIREMENTS

The Swiss Government is planning to electrify a number of the Swiss federal railways, the sum appropriated for the first ten years being 125,000,000 francs annually. The intention is to make most of the electrical machinery and equipment required for this work in Switzerland, and it is stated that the Swiss firms that will build the electrical equipment will require machine tools in considerable quantities. It has been pointed out that the electrical development of the Swiss railroads will enable modern labor-saving machines to be sold in Switzerland even with the present adverse exchange.

PUNCH AND DIE FOR BLANKING AND FORMING METAL CAPS

The accompanying illustration shows a combination punch and die which was built to produce large quantities of metal caps for containers, such as bottles, cans, and jars. The operations of blanking, drawing, and forming the corrugations on the circumference of the cap are all performed with



Blanking and Forming Die for making Metal Caps

this die, which is of the four-post type, the upper and lower members being shown at *A* and *R*, respectively. The lower member holds the blanking die *C* and the forming punch *F*, while the upper member holds the blanking punch *D*, the inner surface of which performs the function of the female forming die. The lower end of plunger *E* also performs part of the forming operation. A drawing ring *B*, supported from beneath by four pins *G* which pass through the lower member and enter the ring *H*, exerts an even pressure on the work due to the provision of a rubber cushion *I*. The stud *J* serves as a guide, and is a sliding fit in a hole in tension plate *M*. Adjustment for tension is secured by tightening or loosening the nuts on rods *L*.

In operation, the end of a roll of the steel from which the caps are made, is fed between the feed-rolls and under the stripper plate *N*. As the punch descends, plunger *E* forms the raised portion of the cap over punch *F*. Punch *D* next cuts the blank to the required size as it enters die *C*. The inner surface of *D* is fluted to correspond with the flutes on punch *F*. The size of these flutes is such that the metal fills them completely as die *D* passes down over punch *F*. The drawing ring *B* draws the blank as it is being formed, in order to insure an even flow of the metal. Experiments were made with several different forms of springs for exerting pressure on the drawing ring, but the rubber cushion *I* finally adopted was found to give better results than any of the springs that were tried.

The return stroke of the press allows the springs on the four posts of the sub-press to force the upper member back to the starting position. The spring surrounding plunger *E* exerts sufficient pressure to assist in extracting the cap from the female forming punch *D*, and the upper end of *E*, which comes in contact with the knock-out rod of the press, serves as a positive knock-out. A piece of steel tubing *K* is used to keep rubber cushion *I* from buckling, and it also serves to prevent oil from coming in contact with the rubber. An air hose, not shown in the illustration, is used for directing a jet of air on the caps as they fall from the upper die. The press is operated at a speed which gives a production of seventy caps per minute. B. S.

* * *

DIMENSIONS OF STRAIGHT FORMING TOOLS

The front face of flat and vertical forming tools is usually ground at an angle from the vertical so as to provide clearance for the tool and, on this account, a trigonometric calculation is involved in determining the depth to which the step on a tool must be ground in order that a step of the specified height will be formed on the work. This will be obvious from reference to the accompanying illustration, in which *A* represents the clearance angle, and *X* indicates the dimension usually desired in grinding the tool, this dimension being at right angles to the front face. The top surface of the forming tool is in the same plane as the horizontal center line of the work, and so dimension *Y* represents the actual distance between the radii of the two surfaces on the work being produced by means of the forming tool.

Dimension *X* for any case can be readily solved by employing the simple trigonometric formula $X = Y \cos A$. The accompanying tables are based upon this formula and upon clearance angles of 9 and 12 degrees, the 9-degree clearance angle being suitable for flat forming tools, and the 12-degree angle, for tools of the vertical type. These tables give the correct value of dimension *X* for any value of *Y* ranging in thousandths of an inch from 0.001 to 1.000 inch. They should prove advantageous to the draftsman when it is essential to specify dimension *X* on a drawing, or to the mechanic re-

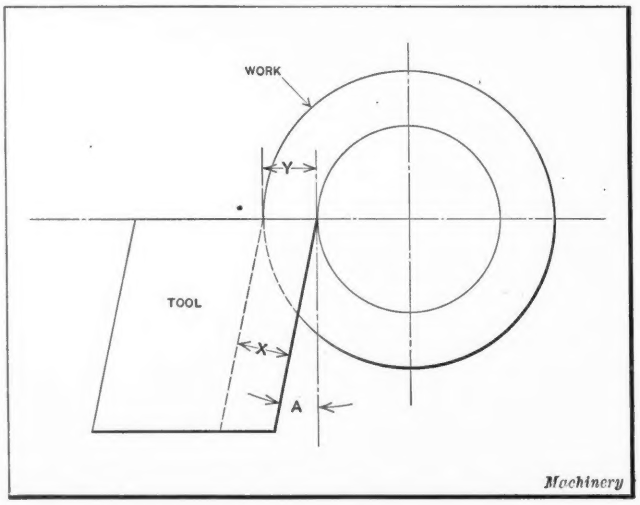


Diagram illustrating Application of Straight Forming Tools to Work

sponsible for grinding the forming tool, as they eliminate the necessity of making the calculation mentioned, and thus reduce chance for error.

In order to illustrate in detail the use of the tables, assume that the difference *Y* between two radii on a piece of work is to be 0.500 inch and that the work is to be turned by means of a flat forming tool having a clearance angle of 9 degrees. Referring to the table, locate 0.500 inch in one of the *Y* columns, and in the corresponding *X* column for a clearance angle of 9 degrees, a value of 0.4939 inch will be found. If the clearance angle were 12 degrees, the value of *X* would be 0.4891 inch. F. C. S.

DEPTH OF STEPS ON STRAIGHT FORMING TOOLS MEASURED AT RIGHT ANGLES TO THE FRONT FACE, CORRESPONDING TO VARIOUS DIFFERENCES BETWEEN RADII ON THE WORK*

Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face	
	Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.
0.001	0.00099	0.00098
0.002	0.00197	0.00196
0.003	0.00296	0.00293
0.004	0.00395	0.00391
0.005	0.00494	0.00489
0.006	0.0059	0.0058
0.007	0.0069	0.0068
0.008	0.0079	0.0078
0.009	0.0089	0.0088
0.010	0.0099	0.0098
0.011	0.0109	0.0108
0.012	0.0118	0.0117
0.013	0.0128	0.0127
0.014	0.0138	0.0137
0.015	0.0148	0.0147
0.016	0.0158	0.0156
0.017	0.0168	0.0166
0.018	0.0177	0.0176
0.019	0.0187	0.0186
0.020	0.0197	0.0196
0.021	0.0207	0.0205
0.022	0.0217	0.0215
0.023	0.0227	0.0225
0.024	0.0237	0.0235
0.025	0.0247	0.0244
0.026	0.0257	0.0254
0.027	0.0267	0.0264
0.028	0.0276	0.0274
0.029	0.0286	0.0284
0.030	0.0296	0.0293
0.031	0.0306	0.0303
0.032	0.0316	0.0313
0.033	0.0326	0.0323
0.034	0.0336	0.0332
0.035	0.0346	0.0342
0.036	0.0356	0.0352
0.037	0.0365	0.0362
0.038	0.0375	0.0372
0.039	0.0385	0.0381
0.040	0.0395	0.0391
0.041	0.0405	0.0401
0.042	0.0415	0.0411
0.043	0.0425	0.0421
0.044	0.0435	0.0430
0.045	0.0444	0.0440
0.046	0.0454	0.0449
0.047	0.0464	0.0459
0.048	0.0474	0.0469
0.049	0.0484	0.0479
0.050	0.0494	0.0490
0.051	0.0504	0.0499
0.052	0.0513	0.0509
0.053	0.0523	0.0518
0.054	0.0533	0.0528
0.055	0.0543	0.0538
0.056	0.0553	0.0548
0.057	0.0563	0.0557
0.058	0.0573	0.0567
0.059	0.0583	0.0577
0.060	0.0593	0.0587
0.061	0.0602	0.0597
0.062	0.0612	0.0606
0.063	0.0622	0.0616
0.064	0.0632	0.0626
0.065	0.0642	0.0636
0.066	0.0652	0.0645
0.067	0.0662	0.0655
0.068	0.0672	0.0665
0.069	0.0681	0.0675
0.070	0.0691	0.0685
0.071	0.0701	0.0694
0.072	0.0711	0.0704
0.073	0.0721	0.0714
0.074	0.0731	0.0724
0.075	0.0741	0.0733
0.076	0.0751	0.0743
0.077	0.0760	0.0753

Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face	
	Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.
0.078	0.0770	0.0763
0.079	0.0780	0.0773
0.080	0.0790	0.0782
0.081	0.0800	0.0792
0.082	0.0810	0.0802
0.083	0.0820	0.0812
0.084	0.0830	0.0822
0.085	0.0839	0.0831
0.086	0.0849	0.0841
0.087	0.0859	0.0851
0.088	0.0869	0.0861
0.089	0.0879	0.0871
0.090	0.0889	0.0880
0.091	0.0899	0.0890
0.092	0.0909	0.0900
0.093	0.0918	0.0910
0.094	0.0928	0.0919
0.095	0.0938	0.0929
0.096	0.0948	0.0939
0.097	0.0958	0.0949
0.098	0.0968	0.0958
0.099	0.0978	0.0968
0.100	0.0988	0.0978
0.101	0.0997	0.0988
0.102	0.1007	0.0998
0.103	0.1017	0.1007
0.104	0.1027	0.1017
0.105	0.1037	0.1027
0.106	0.1047	0.1037
0.107	0.1057	0.1047
0.108	0.1067	0.1056
0.109	0.1076	0.1066
0.110	0.1086	0.1076
0.111	0.1096	0.1086
0.112	0.1106	0.1095
0.113	0.1116	0.1105
0.114	0.1126	0.1115
0.115	0.1136	0.1125
0.116	0.1145	0.1134
0.117	0.1155	0.1144
0.118	0.1165	0.1154
0.119	0.1175	0.1164
0.120	0.1185	0.1174
0.121	0.1195	0.1183
0.122	0.1205	0.1193
0.123	0.1215	0.1203
0.124	0.1225	0.1213
0.125	0.1234	0.1223
0.126	0.1244	0.1232
0.127	0.1254	0.1242
0.128	0.1264	0.1252
0.129	0.1274	0.1262
0.130	0.1284	0.1271
0.131	0.1294	0.1281
0.132	0.1304	0.1291
0.133	0.1313	0.1301
0.134	0.1323	0.1311
0.135	0.1333	0.1320
0.136	0.1343	0.1330
0.137	0.1353	0.1340
0.138	0.1363	0.1350
0.139	0.1373	0.1359
0.140	0.1383	0.1369
0.141	0.1392	0.1379
0.142	0.1402	0.1389
0.143	0.1412	0.1398
0.144	0.1422	0.1408
0.145	0.1432	0.1418
0.146	0.1442	0.1428
0.147	0.1452	0.1437
0.148	0.1462	0.1447
0.149	0.1471	0.1457
0.150	0.1481	0.1467
0.151	0.1491	0.1477
0.152	0.1501	0.1487
0.153	0.1511	0.1496
0.154	0.1521	0.1506
0.155	0.1531	0.1516

Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face	
	Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.
0.156	0.1541	0.1526
0.157	0.1551	0.1535
0.158	0.1560	0.1545
0.159	0.1570	0.1555
0.160	0.1580	0.1565
0.161	0.1590	0.1575
0.162	0.1600	0.1585
0.163	0.1610	0.1594
0.164	0.1620	0.1604
0.165	0.1630	0.1614
0.166	0.1640	0.1624
0.167	0.1649	0.1633
0.168	0.1659	0.1643
0.169	0.1669	0.1653
0.170	0.1679	0.1663
0.171	0.1689	0.1672
0.172	0.1699	0.1682
0.173	0.1709	0.1692
0.174	0.1719	0.1702
0.175	0.1728	0.1712
0.176	0.1738	0.1721
0.177	0.1748	0.1731
0.178	0.1758	0.1741
0.179	0.1768	0.1751
0.180	0.1778	0.1761
0.181	0.1788	0.1770
0.182	0.1798	0.1780
0.183	0.1807	0.1790
0.184	0.1817	0.1800
0.185	0.1827	0.1809
0.186	0.1837	0.1819
0.187	0.1847	0.1829
0.188	0.1857	0.1839
0.189	0.1867	0.1849
0.190	0.1877	0.1858
0.191	0.1886	0.1868
0.192	0.1896	0.1878
0.193	0.1906	0.1888
0.194	0.1916	0.1898
0.195	0.1926	0.1907
0.196	0.1936	0.1917
0.197	0.1946	0.1927
0.198	0.1956	0.1937
0.199	0.1965	0.1946
0.200	0.1975	0.1956
0.201	0.1985	0.1966
0.202	0.1995	0.1976
0.203	0.2005	0.1986
0.204	0.2015	0.1995
0.205	0.2025	0.2005
0.206	0.2035	0.2015
0.207	0.2044	0.2025
0.208	0.2054	0.2034
0.209	0.2064	0.2044
0.210	0.2074	0.2054
0.211	0.2084	0.2064
0.212	0.2094	0.2074
0.213	0.2104	0.2083
0.214	0.2114	0.2093
0.215	0.2123	0.2103
0.216	0.2133	0.2113
0.217	0.2143	0.2123
0.218	0.2153	0.2132
0.219	0.2163	0.2142
0.220	0.2173	0.2152
0.221	0.2183	0.2162
0.222	0.2193	0.2172
0.223	0.2202	0.2181
0.224	0.2212	0.2191
0.225	0.2222	0.2201
0.226	0.2232	0.2211
0.227	0.2242	0.2220
0.228	0.2252	0.2230
0.229	0.2262	0.2240
0.230	0.2272	0.2250
0.231	0.2282	0.2259
0.232	0.2291	0.2269
0.233	0.2301	0.2279
0.234	0.2311	0.2289

Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face	
	Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.
0.235	0.2321	0.2299
0.236	0.2331	0.2308
0.237	0.2341	0.2318
0.238	0.2351	0.2328
0.239	0.2361	0.2338
0.240	0.2370	0.2348
0.241	0.2380	0.2357
0.242	0.2390	0.2367
0.243	0.2400	0.2377
0.244	0.2410	0.2387
0.245	0.2420	0.2396
0.246	0.2430	0.2406
0.247	0.2440	0.2416
0.248	0.2449	0.2426
0.249	0.2459	0.2436
0.250	0.2469	0.2445
0.251	0.2479	0.2455
0.252	0.2489	0.2465
0.253	0.2499	0.2475
0.254	0.2509	0.2484
0.255	0.2519	0.2494
0.256	0.2528	0.2504
0.257	0.2538	0.2514
0.258	0.2548	0.2524
0.259	0.2558	0.2533
0.260	0.2568	0.2543
0.261	0.2578	0.2553
0.262	0.2588	0.2563
0.263	0.2598	0.2572
0.264	0.2607	0.2582
0.265	0.2617	0.2592
0.266	0.2627	0.2602
0.267	0.2637	0.2612
0.268	0.2647	0.2621
0.269	0.2657	0.2631
0.270	0.2667	0.2641
0.271	0.2677	0.2651
0.272	0.2686	0.2661
0.273	0.2696	0.2670
0.274	0.2706	0.2680
0.275	0.2716	0.2690
0.276	0.2726	0.2700
0.277	0.2736	0.2709
0.278	0.2746	0.2719
0.279	0.2756	0.2729
0.280	0.2765	0.2739
0.281	0.2775	0.2749
0.282	0.2785	0.2758
0.283	0.2795	0.2768
0.284	0.2805	0.2778
0.285	0.2815	0.2788
0.286	0.2825	0.2797
0.287	0.2835	0.2807
0.288	0.2844	0.2817
0.289	0.2854	0.2827
0.290	0.2864	0.2837
0.291	0.2874	0.2846
0.292	0.2884	0.2856
0.293	0.2894	0.2866
0.294	0.2904	0.2876
0.295	0.2914	0.2885
0.296	0.2924	0.2895
0.297	0.2933	0.2905
0.298	0.2943	0.2915
0.299	0.2953	0.2925
0.300	0.2963	0.2934
0.301	0.2973	0.2944
0.302	0.2983	0.2954
0.303	0.2993	0.2964
0.304	0.3003	0.2974
0.305	0.3012	0.2983
0.306	0.3022	0.2993
0.307	0.3032	0.3003
0.308	0.3042	0.3013
0.309	0.3052	0.3022
0.310	0.3062	0.3032
0.311	0.3072	0.3042
0.312	0.3082	0.3052
0.313	0.3091	0.3062

Machinery

* Table continued on pages following.

DEPTH OF STEPS ON STRAIGHT FORMING TOOLS MEASURED AT RIGHT ANGLES TO THE FRONT FACE, CORRESPONDING TO VARIOUS DIFFERENCES BETWEEN RADII ON THE WORK—(Continued)

Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face		Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face		Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face		Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face	
	Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.		Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.		Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.		Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.
0.314	0.3101	0.3071	0.393	0.3882	0.3844	0.472	0.4662	0.4617	0.551	0.5442	0.5390
0.315	0.3111	0.3081	0.394	0.3891	0.3854	0.473	0.4672	0.4627	0.552	0.5452	0.5399
0.316	0.3121	0.3091	0.395	0.3901	0.3864	0.474	0.4682	0.4638	0.553	0.5462	0.5409
0.317	0.3131	0.3101	0.396	0.3911	0.3873	0.475	0.4691	0.4646	0.554	0.5472	0.5419
0.318	0.3141	0.3110	0.397	0.3921	0.3883	0.476	0.4701	0.4656	0.555	0.5482	0.5429
0.319	0.3151	0.3120	0.398	0.3931	0.3893	0.477	0.4711	0.4666	0.556	0.5491	0.5439
0.320	0.3161	0.3130	0.399	0.3941	0.3903	0.478	0.4721	0.4675	0.557	0.5501	0.5448
0.321	0.3170	0.3140	0.400	0.3951	0.3913	0.479	0.4731	0.4685	0.558	0.5511	0.5458
0.322	0.3180	0.3149	0.401	0.3961	0.3922	0.480	0.4741	0.4695	0.559	0.5521	0.5468
0.323	0.3190	0.3159	0.402	0.3970	0.3932	0.481	0.4751	0.4705	0.560	0.5531	0.5478
0.324	0.3200	0.3169	0.403	0.3980	0.3942	0.482	0.4761	0.4715	0.561	0.5541	0.5487
0.325	0.3210	0.3179	0.404	0.3990	0.3952	0.483	0.4770	0.4724	0.562	0.5551	0.5497
0.326	0.3220	0.3189	0.405	0.4000	0.3961	0.484	0.4780	0.4734	0.563	0.5561	0.5507
0.327	0.3230	0.3198	0.406	0.4010	0.3971	0.485	0.4790	0.4744	0.564	0.5571	0.5517
0.328	0.3240	0.3208	0.407	0.4020	0.3981	0.486	0.4800	0.4754	0.565	0.5580	0.5527
0.329	0.3249	0.3218	0.408	0.4030	0.3991	0.487	0.4810	0.4764	0.566	0.5590	0.5536
0.330	0.3259	0.3228	0.409	0.4040	0.4001	0.488	0.4820	0.4773	0.567	0.5600	0.5546
0.331	0.3269	0.3238	0.410	0.4049	0.4010	0.489	0.4830	0.4783	0.568	0.5610	0.5556
0.332	0.3279	0.3247	0.411	0.4059	0.4020	0.490	0.4840	0.4793	0.569	0.5620	0.5566
0.333	0.3289	0.3257	0.412	0.4069	0.4030	0.491	0.4849	0.4803	0.570	0.5630	0.5575
0.334	0.3299	0.3267	0.413	0.4079	0.4040	0.492	0.4859	0.4812	0.571	0.5640	0.5585
0.335	0.3309	0.3277	0.414	0.4089	0.4049	0.493	0.4869	0.4822	0.572	0.5650	0.5595
0.336	0.3319	0.3287	0.415	0.4099	0.4059	0.494	0.4879	0.4832	0.573	0.5659	0.5605
0.337	0.3328	0.3296	0.416	0.4109	0.4069	0.495	0.4889	0.4842	0.574	0.5669	0.5615
0.338	0.3338	0.3306	0.417	0.4119	0.4079	0.496	0.4899	0.4852	0.575	0.5679	0.5624
0.339	0.3348	0.3316	0.418	0.4128	0.4089	0.497	0.4909	0.4861	0.576	0.5689	0.5634
0.340	0.3358	0.3326	0.419	0.4138	0.4098	0.498	0.4919	0.4871	0.577	0.5699	0.5644
0.341	0.3368	0.3335	0.420	0.4148	0.4108	0.499	0.4929	0.4881	0.578	0.5709	0.5654
0.342	0.3378	0.3345	0.421	0.4158	0.4118	0.500	0.4939	0.4891	0.579	0.5719	0.5663
0.343	0.3388	0.3355	0.422	0.4168	0.4128	0.501	0.4948	0.4900	0.580	0.5729	0.5673
0.344	0.3398	0.3365	0.423	0.4178	0.4138	0.502	0.4958	0.4910	0.581	0.5738	0.5683
0.345	0.3407	0.3375	0.424	0.4188	0.4147	0.503	0.4968	0.4920	0.582	0.5748	0.5693
0.346	0.3417	0.3384	0.425	0.4198	0.4157	0.504	0.4978	0.4930	0.583	0.5758	0.5703
0.347	0.3427	0.3394	0.426	0.4207	0.4167	0.505	0.4988	0.4940	0.584	0.5768	0.5712
0.348	0.3437	0.3404	0.427	0.4217	0.4177	0.506	0.4998	0.4949	0.585	0.5778	0.5722
0.349	0.3447	0.3414	0.428	0.4227	0.4186	0.507	0.5008	0.4959	0.586	0.5788	0.5732
0.350	0.3457	0.3423	0.429	0.4237	0.4196	0.508	0.5017	0.4969	0.587	0.5798	0.5742
0.351	0.3467	0.3433	0.430	0.4247	0.4206	0.509	0.5027	0.4979	0.588	0.5808	0.5751
0.352	0.3477	0.3443	0.431	0.4257	0.4216	0.510	0.5037	0.4989	0.589	0.5817	0.5761
0.353	0.3486	0.3453	0.432	0.4267	0.4226	0.511	0.5047	0.4998	0.590	0.5827	0.5771
0.354	0.3496	0.3463	0.433	0.4277	0.4235	0.512	0.5057	0.5008	0.591	0.5837	0.5781
0.355	0.3506	0.3472	0.434	0.4286	0.4245	0.513	0.5067	0.5018	0.592	0.5847	0.5791
0.356	0.3516	0.3482	0.435	0.4296	0.4255	0.514	0.5077	0.5028	0.593	0.5857	0.5800
0.357	0.3526	0.3492	0.436	0.4306	0.4265	0.515	0.5087	0.5037	0.594	0.5867	0.5810
0.358	0.3536	0.3502	0.437	0.4316	0.4274	0.516	0.5096	0.5047	0.595	0.5877	0.5820
0.359	0.3546	0.3511	0.438	0.4326	0.4284	0.517	0.5106	0.5057	0.596	0.5887	0.5830
0.360	0.3556	0.3521	0.439	0.4336	0.4294	0.518	0.5116	0.5067	0.597	0.5897	0.5839
0.361	0.3565	0.3531	0.440	0.4346	0.4304	0.519	0.5126	0.5077	0.598	0.5906	0.5849
0.362	0.3575	0.3541	0.441	0.4356	0.4314	0.520	0.5136	0.5086	0.599	0.5916	0.5859
0.363	0.3585	0.3551	0.442	0.4365	0.4323	0.521	0.5146	0.5096	0.600	0.5926	0.5869
0.364	0.3595	0.3560	0.443	0.4375	0.4333	0.522	0.5156	0.5106	0.601	0.5936	0.5878
0.365	0.3605	0.3570	0.444	0.4385	0.4343	0.523	0.5166	0.5116	0.602	0.5946	0.5888
0.366	0.3615	0.3580	0.445	0.4395	0.4353	0.524	0.5175	0.5125	0.603	0.5956	0.5898
0.367	0.3625	0.3590	0.446	0.4405	0.4362	0.525	0.5185	0.5135	0.604	0.5966	0.5908
0.368	0.3635	0.3600	0.447	0.4415	0.4372	0.526	0.5195	0.5145	0.605	0.5976	0.5918
0.369	0.3644	0.3609	0.448	0.4425	0.4382	0.527	0.5205	0.5155	0.606	0.5985	0.5927
0.370	0.3654	0.3619	0.449	0.4435	0.4392	0.528	0.5215	0.5165	0.607	0.5995	0.5937
0.371	0.3664	0.3629	0.450	0.4445	0.4402	0.529	0.5225	0.5174	0.608	0.6005	0.5947
0.372	0.3674	0.3639	0.451	0.4454	0.4411	0.530	0.5235	0.5184	0.609	0.6015	0.5957
0.373	0.3684	0.3648	0.452	0.4464	0.4421	0.531	0.5245	0.5194	0.610	0.6025	0.5967
0.374	0.3694	0.3658	0.453	0.4474	0.4431	0.532	0.5254	0.5204	0.611	0.6035	0.5976
0.375	0.3704	0.3668	0.454	0.4484	0.4441	0.533	0.5264	0.5213	0.612	0.6045	0.5986
0.376	0.3714	0.3678	0.455	0.4494	0.4451	0.534	0.5274	0.5223	0.613	0.6055	0.5996
0.377	0.3724	0.3688	0.456	0.4504	0.4460	0.535	0.5284	0.5233	0.614	0.6064	0.6006
0.378	0.3733	0.3697	0.457	0.4514	0.4470	0.536	0.5294	0.5243	0.615	0.6074	0.6016
0.379	0.3743	0.3707	0.458	0.4524	0.4480	0.537	0.5304	0.5253	0.616	0.6084	0.6025
0.380	0.3753	0.3717	0.459	0.4533	0.4490	0.538	0.5314	0.5262	0.617	0.6094	0.6035
0.381	0.3763	0.3727	0.460	0.4543	0.4499	0.539	0.5324	0.5272	0.618	0.6104	0.6045
0.382	0.3773	0.3736	0.461	0.4553	0.4509	0.540	0.5333	0.5282	0.619	0.6114	0.6055
0.383	0.3783	0.3746	0.462	0.4563	0.4519	0.541	0.5343	0.5292	0.620	0.6124	0.6064
0.384	0.3793	0.3756	0.463	0.4573	0.4529	0.542	0.5353	0.5302	0.621	0.6134	0.6074
0.385	0.3803	0.3766	0.464	0.4583	0.4539	0.543	0.5363	0.5311	0.622	0.6143	0.6084
0.386	0.3812	0.3776	0.465	0.4593	0.4548	0.544	0.5373	0.5321	0.623	0.6153	0.6094
0.387	0.3822	0.3785	0.466	0.4603	0.4558	0.545	0.5383	0.5331	0.624	0.6163	0.6104
0.388	0.3832	0.3795	0.467	0.4612	0.4568	0.546	0.5393	0.5341	0.625	0.6173	0.6113
0.389	0.3842	0.3805	0.468	0.4622	0.4578	0.547	0.5403	0.5350	0.626	0.6183	0.6123
0.390	0.3852	0.3815	0.469	0.4632	0.4587	0.548	0.5412	0.5360	0.627	0.6193	0.6133
0.391	0.3862	0.3824	0.470	0.4642	0.4597	0.549	0.5422	0.5370	0.628	0.6203	0.6143
0.392	0.3872	0.3834	0.471	0.4652	0.4607	0.550	0.5432	0.5380	0.629	0.6213	0.6152

Machinery

DEPTH OF STEPS ON STRAIGHT FORMING TOOLS MEASURED AT RIGHT ANGLES TO THE FRONT FACE, CORRESPONDING TO VARIOUS DIFFERENCES BETWEEN RADII ON THE WORK—(Continued)

Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face		Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face		Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face		Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face	
	Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.		Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.		Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.		Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.
0.630	0.6222	0.6162	0.709	0.7003	0.6935	0.788	0.7783	0.7708	0.867	0.8563	0.8481
0.631	0.6232	0.6172	0.710	0.7012	0.6945	0.789	0.7793	0.7718	0.868	0.8573	0.8490
0.632	0.6242	0.6182	0.711	0.7022	0.6955	0.790	0.7803	0.7727	0.869	0.8583	0.8500
0.633	0.6252	0.6192	0.712	0.7032	0.6964	0.791	0.7812	0.7737	0.870	0.8593	0.8510
0.634	0.6262	0.6201	0.713	0.7042	0.6974	0.792	0.7822	0.7747	0.871	0.8603	0.8520
0.635	0.6272	0.6211	0.714	0.7052	0.6984	0.793	0.7832	0.7757	0.872	0.8613	0.8529
0.636	0.6282	0.6221	0.715	0.7062	0.6994	0.794	0.7842	0.7766	0.873	0.8622	0.8539
0.637	0.6292	0.6231	0.716	0.7072	0.7003	0.795	0.7852	0.7776	0.874	0.8632	0.8549
0.638	0.6301	0.6241	0.717	0.7082	0.7013	0.796	0.7862	0.7786	0.875	0.8642	0.8559
0.639	0.6311	0.6250	0.718	0.7092	0.7023	0.797	0.7872	0.7796	0.876	0.8652	0.8569
0.640	0.6321	0.6260	0.719	0.7101	0.7033	0.798	0.7882	0.7805	0.877	0.8662	0.8578
0.641	0.6331	0.6270	0.720	0.7111	0.7043	0.799	0.7892	0.7815	0.878	0.8672	0.8588
0.642	0.6341	0.6280	0.721	0.7121	0.7052	0.800	0.7901	0.7825	0.879	0.8682	0.8598
0.643	0.6351	0.6289	0.722	0.7131	0.7062	0.801	0.7911	0.7835	0.880	0.8692	0.8608
0.644	0.6361	0.6299	0.723	0.7141	0.7072	0.802	0.7921	0.7845	0.881	0.8701	0.8617
0.645	0.6371	0.6309	0.724	0.7151	0.7082	0.803	0.7931	0.7854	0.882	0.8711	0.8627
0.646	0.6380	0.6319	0.725	0.7161	0.7092	0.804	0.7941	0.7864	0.883	0.8721	0.8637
0.647	0.6390	0.6329	0.726	0.7171	0.7101	0.805	0.7951	0.7874	0.884	0.8731	0.8647
0.648	0.6400	0.6338	0.727	0.7180	0.7111	0.806	0.7961	0.7884	0.885	0.8741	0.8657
0.649	0.6410	0.6348	0.728	0.7190	0.7121	0.807	0.7971	0.7894	0.886	0.8751	0.8666
0.650	0.6420	0.6358	0.729	0.7200	0.7131	0.808	0.7980	0.7903	0.887	0.8761	0.8676
0.651	0.6430	0.6368	0.730	0.7210	0.7140	0.809	0.7990	0.7913	0.888	0.8771	0.8686
0.652	0.6440	0.6378	0.731	0.7220	0.7150	0.810	0.8000	0.7923	0.889	0.8780	0.8696
0.653	0.6450	0.6387	0.732	0.7230	0.7160	0.811	0.8010	0.7933	0.890	0.8790	0.8705
0.654	0.6459	0.6397	0.733	0.7240	0.7170	0.812	0.8020	0.7943	0.891	0.8800	0.8715
0.655	0.6469	0.6407	0.734	0.7250	0.7180	0.813	0.8030	0.7952	0.892	0.8810	0.8725
0.656	0.6479	0.6417	0.735	0.7259	0.7189	0.814	0.8040	0.7962	0.893	0.8820	0.8735
0.657	0.6489	0.6426	0.736	0.7269	0.7199	0.815	0.8050	0.7972	0.894	0.8830	0.8745
0.658	0.6499	0.6436	0.737	0.7279	0.7209	0.816	0.8059	0.7982	0.895	0.8840	0.8754
0.659	0.6509	0.6446	0.738	0.7289	0.7219	0.817	0.8069	0.7992	0.896	0.8850	0.8764
0.660	0.6519	0.6456	0.739	0.7299	0.7228	0.818	0.8079	0.8001	0.897	0.8859	0.8774
0.661	0.6529	0.6465	0.740	0.7309	0.7238	0.819	0.8089	0.8011	0.898	0.8869	0.8784
0.662	0.6538	0.6475	0.741	0.7319	0.7248	0.820	0.8099	0.8021	0.899	0.8879	0.8793
0.663	0.6548	0.6485	0.742	0.7329	0.7258	0.821	0.8109	0.8031	0.900	0.8889	0.8803
0.664	0.6558	0.6495	0.743	0.7338	0.7268	0.822	0.8119	0.8040	0.901	0.8899	0.8813
0.665	0.6568	0.6505	0.744	0.7348	0.7277	0.823	0.8129	0.8050	0.902	0.8909	0.8823
0.666	0.6578	0.6514	0.745	0.7358	0.7287	0.824	0.8138	0.8060	0.903	0.8919	0.8833
0.667	0.6588	0.6524	0.746	0.7368	0.7297	0.825	0.8148	0.8070	0.904	0.8929	0.8842
0.668	0.6598	0.6534	0.747	0.7378	0.7307	0.826	0.8158	0.8080	0.905	0.8939	0.8852
0.669	0.6608	0.6544	0.748	0.7388	0.7316	0.827	0.8168	0.8089	0.906	0.8948	0.8862
0.670	0.6617	0.6554	0.749	0.7398	0.7326	0.828	0.8178	0.8099	0.907	0.8958	0.8872
0.671	0.6627	0.6563	0.750	0.7408	0.7336	0.829	0.8188	0.8109	0.908	0.8968	0.8882
0.672	0.6637	0.6573	0.751	0.7417	0.7346	0.830	0.8198	0.8119	0.909	0.8978	0.8891
0.673	0.6647	0.6583	0.752	0.7427	0.7356	0.831	0.8207	0.8128	0.910	0.8988	0.8901
0.674	0.6657	0.6593	0.753	0.7437	0.7365	0.832	0.8217	0.8138	0.911	0.8998	0.8911
0.675	0.6667	0.6602	0.754	0.7447	0.7375	0.833	0.8227	0.8148	0.912	0.9008	0.8921
0.676	0.6677	0.6612	0.755	0.7457	0.7385	0.834	0.8237	0.8158	0.913	0.9017	0.8930
0.677	0.6687	0.6622	0.756	0.7467	0.7395	0.835	0.8247	0.8168	0.914	0.9027	0.8940
0.678	0.6696	0.6632	0.757	0.7477	0.7405	0.836	0.8257	0.8177	0.915	0.9037	0.8950
0.679	0.6706	0.6642	0.758	0.7487	0.7414	0.837	0.8267	0.8187	0.916	0.9047	0.8960
0.680	0.6716	0.6651	0.759	0.7496	0.7424	0.838	0.8277	0.8197	0.917	0.9057	0.8970
0.681	0.6726	0.6661	0.760	0.7506	0.7434	0.839	0.8287	0.8207	0.918	0.9067	0.8979
0.682	0.6736	0.6671	0.761	0.7516	0.7444	0.840	0.8296	0.8216	0.919	0.9077	0.8989
0.683	0.6746	0.6681	0.762	0.7526	0.7453	0.841	0.8306	0.8226	0.920	0.9087	0.8999
0.684	0.6756	0.6690	0.763	0.7536	0.7463	0.842	0.8316	0.8236	0.921	0.9097	0.9009
0.685	0.6766	0.6700	0.764	0.7546	0.7473	0.843	0.8326	0.8246	0.922	0.9106	0.9018
0.686	0.6775	0.6710	0.765	0.7556	0.7483	0.844	0.8336	0.8256	0.923	0.9116	0.9028
0.687	0.6785	0.6720	0.766	0.7566	0.7493	0.845	0.8346	0.8265	0.924	0.9126	0.9038
0.688	0.6795	0.6730	0.767	0.7575	0.7502	0.846	0.8356	0.8275	0.925	0.9136	0.9048
0.689	0.6805	0.6739	0.768	0.7585	0.7512	0.847	0.8366	0.8285	0.926	0.9146	0.9058
0.690	0.6815	0.6749	0.769	0.7595	0.7522	0.848	0.8376	0.8295	0.927	0.9156	0.9067
0.691	0.6825	0.6759	0.770	0.7605	0.7532	0.849	0.8385	0.8304	0.928	0.9166	0.9077
0.692	0.6835	0.6769	0.771	0.7615	0.7542	0.850	0.8395	0.8314	0.929	0.9176	0.9087
0.693	0.6845	0.6779	0.772	0.7625	0.7551	0.851	0.8405	0.8324	0.930	0.9185	0.9097
0.694	0.6854	0.6788	0.773	0.7635	0.7561	0.852	0.8415	0.8334	0.931	0.9195	0.9106
0.695	0.6864	0.6798	0.774	0.7645	0.7571	0.853	0.8425	0.8344	0.932	0.9205	0.9116
0.696	0.6874	0.6808	0.775	0.7654	0.7581	0.854	0.8435	0.8353	0.933	0.9215	0.9126
0.697	0.6884	0.6818	0.776	0.7664	0.7590	0.855	0.8445	0.8363	0.934	0.9225	0.9136
0.698	0.6894	0.6827	0.777	0.7674	0.7600	0.856	0.8455	0.8373	0.935	0.9235	0.9146
0.699	0.6904	0.6837	0.778	0.7684	0.7610	0.857	0.8464	0.8383	0.936	0.9245	0.9155
0.700	0.6914	0.6847	0.779	0.7694	0.7620	0.858	0.8474	0.8392	0.937	0.9255	0.9165
0.701	0.6924	0.6857	0.780	0.7704	0.7629	0.859	0.8484	0.8402	0.938	0.9264	0.9175
0.702	0.6933	0.6867	0.781	0.7714	0.7639	0.860	0.8494	0.8412	0.939	0.9274	0.9185
0.703	0.6943	0.6876	0.782	0.7724	0.7649	0.861	0.8504	0.8422	0.940	0.9284	0.9195
0.704	0.6953	0.6886	0.783	0.7733	0.7659	0.862	0.8514	0.8432	0.941	0.9294	0.9204
0.705	0.6963	0.6896	0.784	0.7743	0.7669	0.863	0.8524	0.8441	0.942	0.9304	0.9214
0.706	0.6973	0.6906	0.785	0.7753	0.7678	0.864	0.8534	0.8451	0.943	0.9314	0.9224
0.707	0.6983	0.6915	0.786	0.7763	0.7688	0.865	0.8543	0.8461	0.944	0.9324	0.9234
0.708	0.6993	0.6925	0.787	0.7773	0.7698	0.866	0.8553	0.8471	0.945	0.9334	0.9243

Machinery

DEPTH OF STEPS ON STRAIGHT FORMING TOOLS MEASURED AT RIGHT ANGLES TO THE FRONT FACE, CORRESPONDING TO VARIOUS DIFFERENCES BETWEEN RADII ON THE WORK—(Continued)

Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face		Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face		Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face		Y (Difference between Radii on Work)	Dimension X on Tool, Measured at Right Angles to Front Face	
	Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.		Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.		Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.		Clearance Angle, 9 Deg.	Clearance Angle, 12 Deg.
0.946	0.9343	0.9253	0.960	0.9482	0.9390	0.974	0.9620	0.9527	0.988	0.9758	0.9664
0.947	0.9353	0.9263	0.961	0.9492	0.9400	0.975	0.9630	0.9537	0.989	0.9768	0.9674
0.948	0.9363	0.9273	0.962	0.9501	0.9410	0.976	0.9640	0.9547	0.990	0.9778	0.9684
0.949	0.9373	0.9283	0.963	0.9511	0.9419	0.977	0.9650	0.9556	0.991	0.9788	0.9693
0.950	0.9383	0.9292	0.964	0.9521	0.9429	0.978	0.9660	0.9566	0.992	0.9798	0.9703
0.951	0.9393	0.9302	0.965	0.9531	0.9439	0.979	0.9669	0.9576	0.993	0.9808	0.9713
0.952	0.9403	0.9312	0.966	0.9541	0.9449	0.980	0.9679	0.9586	0.994	0.9818	0.9723
0.953	0.9413	0.9322	0.967	0.9551	0.9459	0.981	0.9689	0.9596	0.995	0.9827	0.9732
0.954	0.9422	0.9331	0.968	0.9561	0.9468	0.982	0.9699	0.9605	0.996	0.9837	0.9742
0.955	0.9432	0.9341	0.969	0.9571	0.9478	0.983	0.9709	0.9615	0.997	0.9847	0.9752
0.956	0.9442	0.9351	0.970	0.9581	0.9488	0.984	0.9719	0.9625	0.998	0.9857	0.9762
0.957	0.9452	0.9361	0.971	0.9590	0.9498	0.985	0.9729	0.9635	0.999	0.9867	0.9772
0.958	0.9462	0.9371	0.972	0.9600	0.9507	0.986	0.9739	0.9644	1.000	0.9877	0.9781
0.959	0.9472	0.9380	0.973	0.9610	0.9517	0.987	0.9748	0.9654			

Machinery

ECONOMICAL SELECTION OF MATERIALS

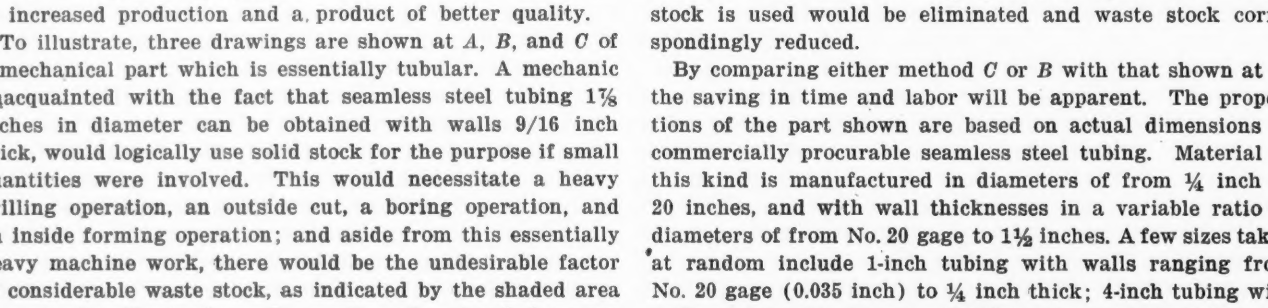
Shop managers could effect considerable saving in labor and waste stock by a more general use of materials that require a minimum of reworking after they come from the supply house. Many raw or semi-finished materials are on the market with which the manufacturer or consumer is acquainted in only a general way; and in numerous instances a closer study of the properties of such materials would lead to increased production and a product of better quality.

To illustrate, three drawings are shown at *A*, *B*, and *C* of a mechanical part which is essentially tubular. A mechanic unacquainted with the fact that seamless steel tubing 1⅞ inches in diameter can be obtained with walls 9/16 inch thick, would logically use solid stock for the purpose if small quantities were involved. This would necessitate a heavy drilling operation, an outside cut, a boring operation, and an inside forming operation; and aside from this essentially heavy machine work, there would be the undesirable factor of considerable waste stock, as indicated by the shaded area at *A* in the illustration. If, on the other hand, he were acquainted with the range of sizes and wall thicknesses in which seamless steel tubing is regularly or specially manufactured, he would secure tubular stock of the right size and proper kind of steel, and approach the matter in a way which would be more economical, whether the quantities involved were large or small. The same part, produced as shown at *A* would be more satisfactorily made by swaging tubing having a wall thickness equal to the greatest wall thickness of the finished product, or slightly less, if a portion were to be upset (see view *B*). The swaging operation would give at once the correct diameter of opening at *a*, sufficient thickness for the convex tapered bore *b* (with less stock to remove in this operation than would be necessary after drilling solid stock), and would also eliminate the heavy outside cut *c*. The boring and inside forming would be reduced to a minimum.

If facilities for swaging were not provided and the proposition was that of smaller quantity production, the part could still be made by using tubing having an internal diameter equal to the smallest internal diameter of the finished product and an outside diameter equal to the greatest outside diameter of the part. In this instance, as illustrated at *C*, the boring operation would be heavier than that required in the preceding case and an outside cut *c* would have to be taken, but the heavy drilling operation required when solid stock is used would be eliminated and waste stock correspondingly reduced.

By comparing either method *C* or *B* with that shown at *A*, the saving in time and labor will be apparent. The proportions of the part shown are based on actual dimensions of commercially procurable seamless steel tubing. Material of this kind is manufactured in diameters of from ¼ inch to 20 inches, and with wall thicknesses in a variable ratio to diameters of from No. 20 gage to 1½ inches. A few sizes taken at random include 1-inch tubing with walls ranging from No. 20 gage (0.035 inch) to ¼ inch thick; 4-inch tubing with walls of from No. 11 gage (0.120 inch) to 1 inch thick; and 9-inch tubing with walls ranging from ¼ inch to 1⅛ inches thick. All of these sizes are made by piercing solid billets. This material is made in a number of different kinds of steel, which are so annealed as to give practically any necessary quality for machining. For instance, where it is necessary to expand the tubing, sufficient ductility will be found, yet the strength will in no way be sacrificed if tubing is purchased after its requirements for some particular use have been passed upon by the dealer or the manufacturer of the tubing. Tubing, in the alloy steels, is so uniform that no unusual difficulties in machining should be experienced. Special heat-treatment is often given for specific purposes.

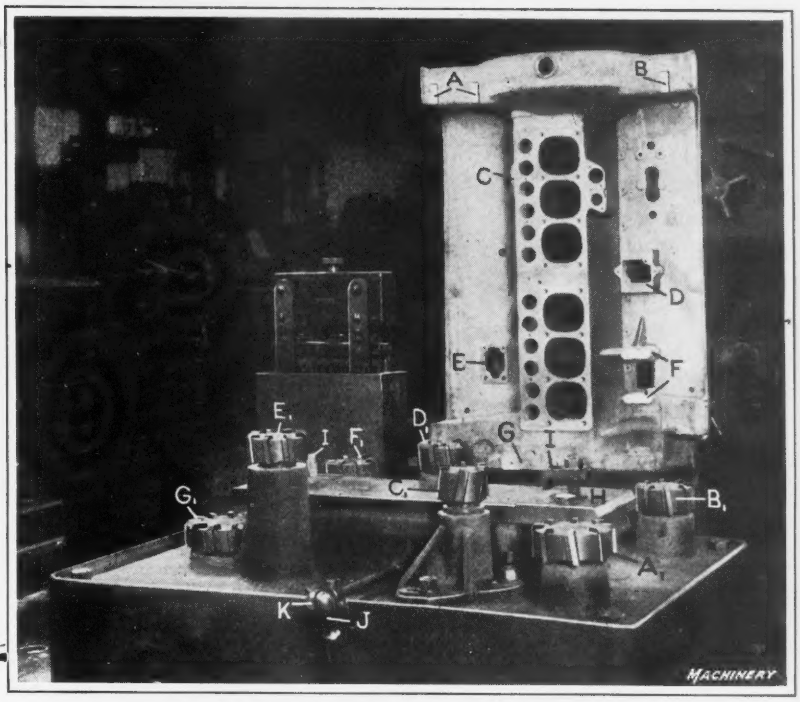
The manager who studies materials with the view of becoming acquainted with such information, can frequently effect economies, and raise the standard for quality.



Three Methods of producing a Tubular Part. The Metal removed in machining is indicated by Section Lines

Special Machines and Tools in the Chandler Plant

Equipment Used by the Chandler Motor Car Co., Cleveland, Ohio, for Milling Crankcases, Boring and Reaming Crankshaft and Camshaft Bearings, and Numerous other Operations



MEN who keep closely in touch with developments in machine tool design have come to regard the special single-purpose tool as an accepted institution in American manufacturing plants. A few years ago, many manufacturers were hostile to this type of equipment, chiefly on account of the fact that it was only adapted for the performance of a single class of work, and where the job would not keep the machine constantly employed a heavy item of overhead was inevitable. Also, in the event of a change in the design of the product, a special machine tool often became valueless. For those reasons, the machine shops of only a few years ago were equipped almost entirely with standard machine tools, but today there is a distinct trend toward specialization in the design of equipment that is to be used in machining duplicate parts. This statement must not be misconstrued. Doubtless the number of standard machine tools in the average plant will always far outnumber those of special construction, but as the economy in first cost and the high productivity of the special machine become better known, the planning departments of progressive industrial organizations are likely to give more and more time to the searching out of those operations which could be efficiently handled on special machines, and arrangements will then be made to have such equipment designed and built in the factory where it is to be used, or else to have the work done by experienced machine tool builders. Under favorable circumstances, the saving effected by a machine especially designed for the job would more than defray the cost of the machine, even though it was to be used in producing a part of the product which is likely to become obsolete after the special machine has been in operation for only a short period of time.

Special Machines Used by the Chandler Motor Car Co.

At the plant of the Chandler Motor Car Co., Cleveland, Ohio, a number of interesting special machine tools are utilized, and it is the purpose of this article to explain the merits of some of these special tools for the performance of their respective jobs. Briefly summarized, the advantages of a machine which has been developed to meet the peculiar requirements of a specified operation are likely to be as follows: (1) Lower first cost; (2) greater efficiency in production; (3) simplicity of design and suitability for operation by semi-skilled labor; (4) economy in the use of floor space. Naturally there will be other advantages in the numerous cases where special machines are used.

Special Milling Machine for Operation on Chandler Crankcases

The heading illustration shows a seven-spindle milling machine which operates simultaneously on faces *A*, *B*, *C*, *D*, *E*, *F*, and *G* of the crankcase shown standing on end by the machine. It will be noted that the milling cutters are lettered to correspond with the faces of the casting on which they operate. Before this special miller was developed, the work of handling these pieces was done on a large multiple-spindle machine and two knee-type millers. It was necessary to set up the castings three different times, which involved a serious

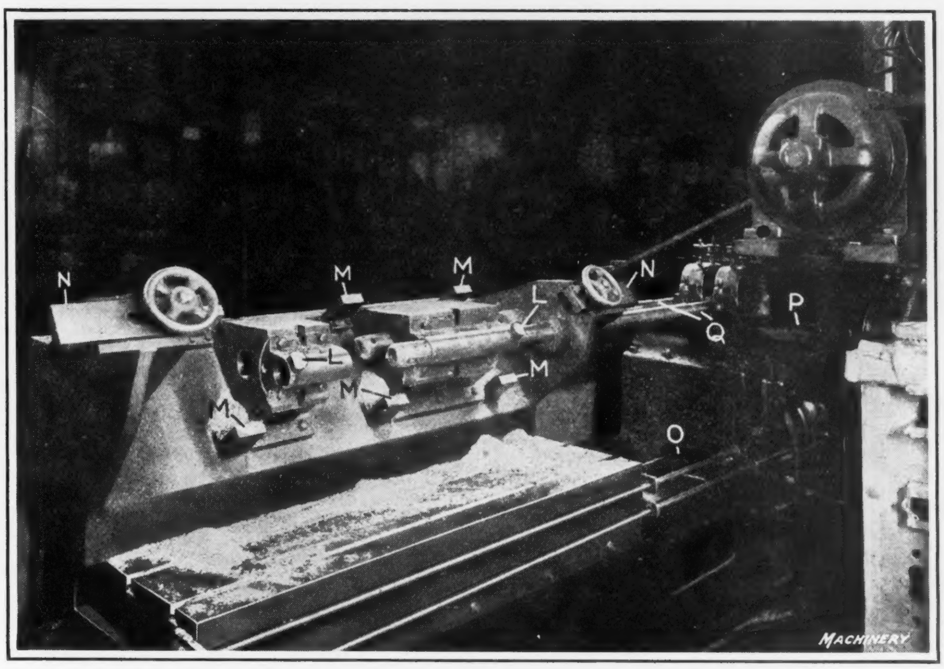


Fig. 1. Special-purpose Duplex Boring Machine for simultaneously rough-boring the Crankshaft and Camshaft Bearings of Chandler Crankcases

loss in labor efficiency; also, the three machines occupied a great deal more floor space than is taken up by a single compact tool which provides for simultaneously finishing all seven surfaces on the castings. The crankcase casting is located on the machine by two pilots, one of which is shown at *H*, which enter the valve push-rod holes; and two straps *I* hold the casting down on a surface that has been previously milled.

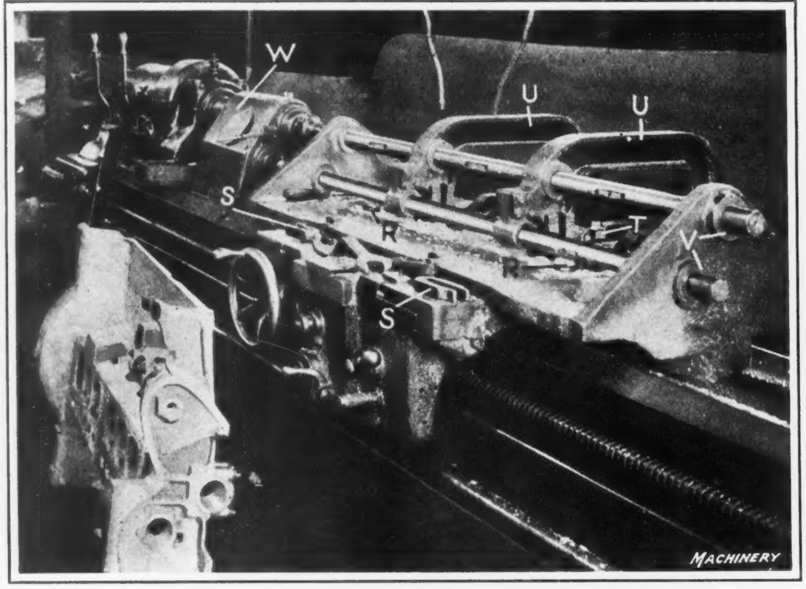


Fig. 2. Lathe equipped with Work-holding Fixture and Duplex Head for simultaneously reaming Crankshaft and Camshaft Bearings of Chandler Crankcases

This machine is arranged with individual motor drive from which power is transmitted through a main clutch to a train of gears contained in the bed of the machine, that provides for driving the various milling cutters at the correct peripheral speeds. After a casting has been set up ready for performing the machining operations, the clutch is engaged by manipulating lever *J*. With the machine in operation, it is then necessary to bring the feed into operation, which is accomplished by the manipulation of knob *K*. On this special machine, the rate of output obtained in milling seven surfaces on the castings is from 140 to 150 finished crankcases in a nine-hour day, and as many as 200 castings have been milled on the machine during this operating period.

Rough-boring and Line-reaming Operations on Crankshaft and Camshaft Bearings

From the milling machine shown in the heading illustration the crankcases are transferred to a machine illustrated in Fig. 1 on which the crankshaft and camshaft bearings are rough-bored. Following the same practice as in milling, location of the castings is accomplished by means of two pilots *L*, which enter the same valve push-rod holes that have been previously utilized. Five hardened blocks *M* engage the milled face of the casting, and clamping is accomplished by handwheels and straps *N*. It will be apparent that the work-holding fixture is mounted on a carriage which slides on the ways of the boring machine bed, this movement being accomplished by means of a lead-screw *O*. The machine is equipped with individual motor drive, and power is transmitted to the two spindles by means of a long helical pinion *P* that meshes with gears on the two spindles *Q*. It will be evident that bushings are provided on the work-holding fixture to maintain the boring-bars in accurate alignment. On this job the rate of production obtained is 150 crankcases that have been rough-bored in the crankshaft and camshaft bearings in a nine-hour working day.

After rough-boring the bearings on the machine illustrated in Fig. 1, the castings are taken to a machine which provides for simultaneously line-reaming the crankshaft and camshaft bearings. As in the two previous operations, location is accomplished by means of pilots which enter two of the valve push-rod holes, the work being clamped down on its previously milled surface. These pilots are shown at *R*, Fig. 2. Clamping down of the casting is accomplished by means of two U-shaped straps *S*, which are arranged to slide under the heads of two clamping bolts, one of which is shown at *T*. This arrangement saves time in setting up the work, as it is only necessary to loosen each nut one-half turn, after which the clamp can be withdrawn and the work lifted off the machine over the head of the bolt. This operation is performed with Kelly aligning bars and reamers made by the Kelly Reamer Co., of Cleveland, Ohio, the blades of which are loosened and turned into the bars to enable them to pass through the guide bushings on the fixture, this feature having been worked out by the Chandler tool designers in collaboration with the Kelly Reamer Co.

Accurate alignment of the two reamers is absolutely essential for the satisfactory performance of this operation, and as there is a wide span between their driving ends and outboard ends, supplementary support is afforded by means of two sets of intermediate bearings carried by arms *U*. These arms are pivoted so that they may be swung down into place to receive the reamers after the casting has been set up in the fixture on the machine. The reamers are next threaded

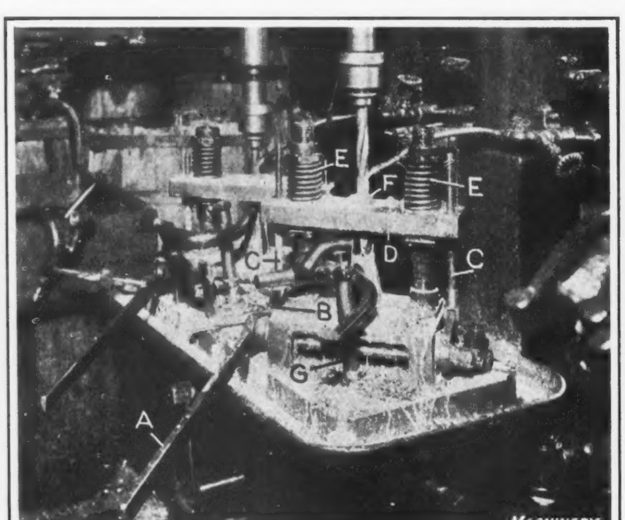


Fig. 3. Universal Drilling Jig used at the Chandler Plant for drilling and reaming Motor Car Steering Arms

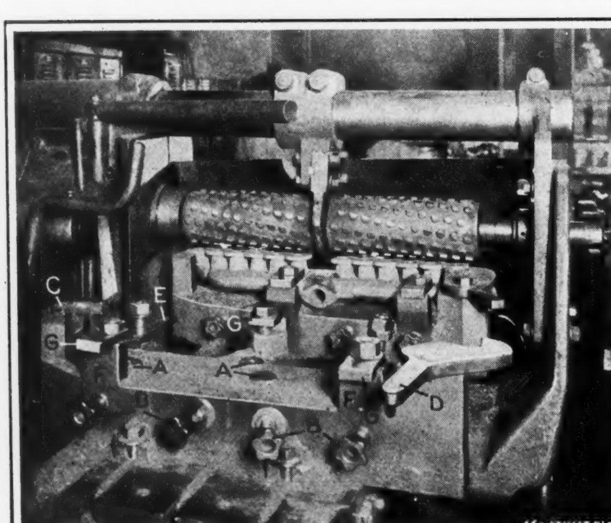


Fig. 4. Milling Machine equipped with Two Jigs for milling the Inlet and Exhaust Port Flanges on Manifolds

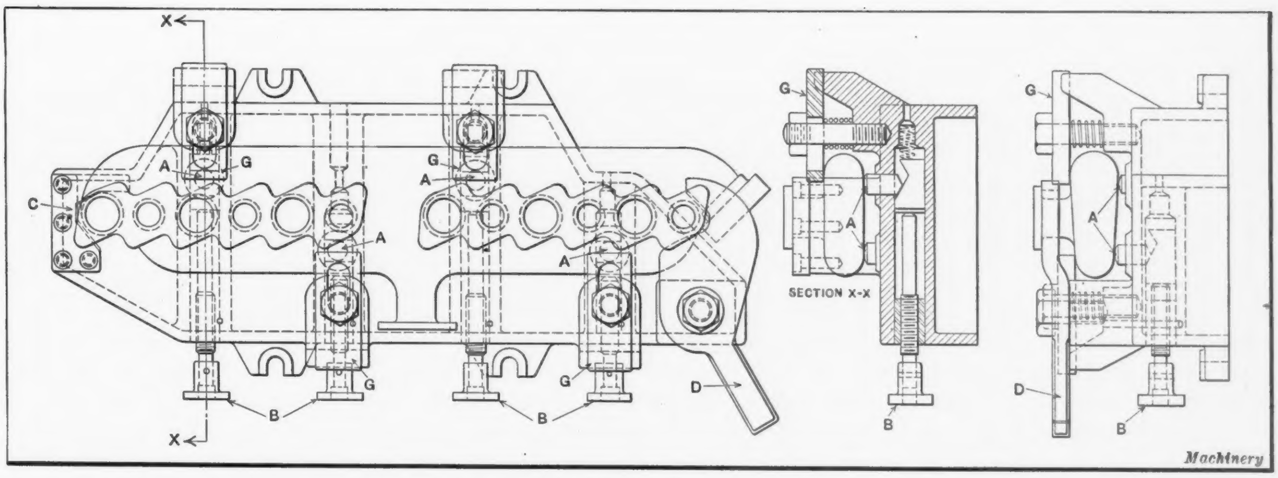


Fig. 5. Plan and Cross-sectional Views and End Elevation of One of the Milling Fixtures shown on the Machine illustrated in Fig. 4

through the work, and the guide bushings carried by arms *U* hold the cutters accurately in position to start their work. It will be seen that on the fixture of the machine there is a final outboard bearing *V* for holding each of the reamers. Arms *U* are clamped down to the fixture to secure them rigidly in place.

This machine was developed from a heavy-duty engine lathe built by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, which was used as a base. Connected to the spindle of the machine, it will be seen that there is a special duplex head *W* that provides for driving the two reamers through universal joints. The lathe carriage supports a special work-holding fixture, which is furnished with six hardened pads that hold the casting from its milled face, and it is traversed along the bed of the machine by means of the feed movement of the carriage. Hence, when the casting has been set up, the carriage provides for traversing the fixture so that the work is fed against the rotating reamers that occupy a fixed longitudinal position. For the performance of this job the average rate of output is 150 castings in twenty hours; it is necessary to employ two shifts of men for performing this line-reaming operation on the work, in order to obtain the required number of finished castings.

Application of Drilling Jigs of Standard Construction

In the motor car industry, cars of new models are brought out annually by many manufacturers, and these modifications of design of the product frequently involve the necessity of changing a large part of the manufacturing equipment in the plant. As a result, most motor car builders have enormous storage spaces in which obsolete tools are kept in storage because, although they are classed as "obsolete," they cannot be discarded due to the necessity of keeping the tools for use in machining replacement parts for delivery to service stations that are called upon to make repairs on cars that have not been manufactured as a regular product for several years.

In the case of drilling jigs, a satisfactory method of greatly reducing the loss resulting from the necessity of discarding special tools has been made possible through the introduction of what are known as standard jigs. They are sold by the National Sales Engineering Corporation, Kresge Bldg., Detroit, Mich., and only need to have special V-blocks added, or other means of holding a given piece of work in place in the jig. These jigs are made in a variety of different sizes to suit various classes of work. Fig. 3 illustrates a two-spindle drilling machine built by the Barnes Drill Co., Rock-

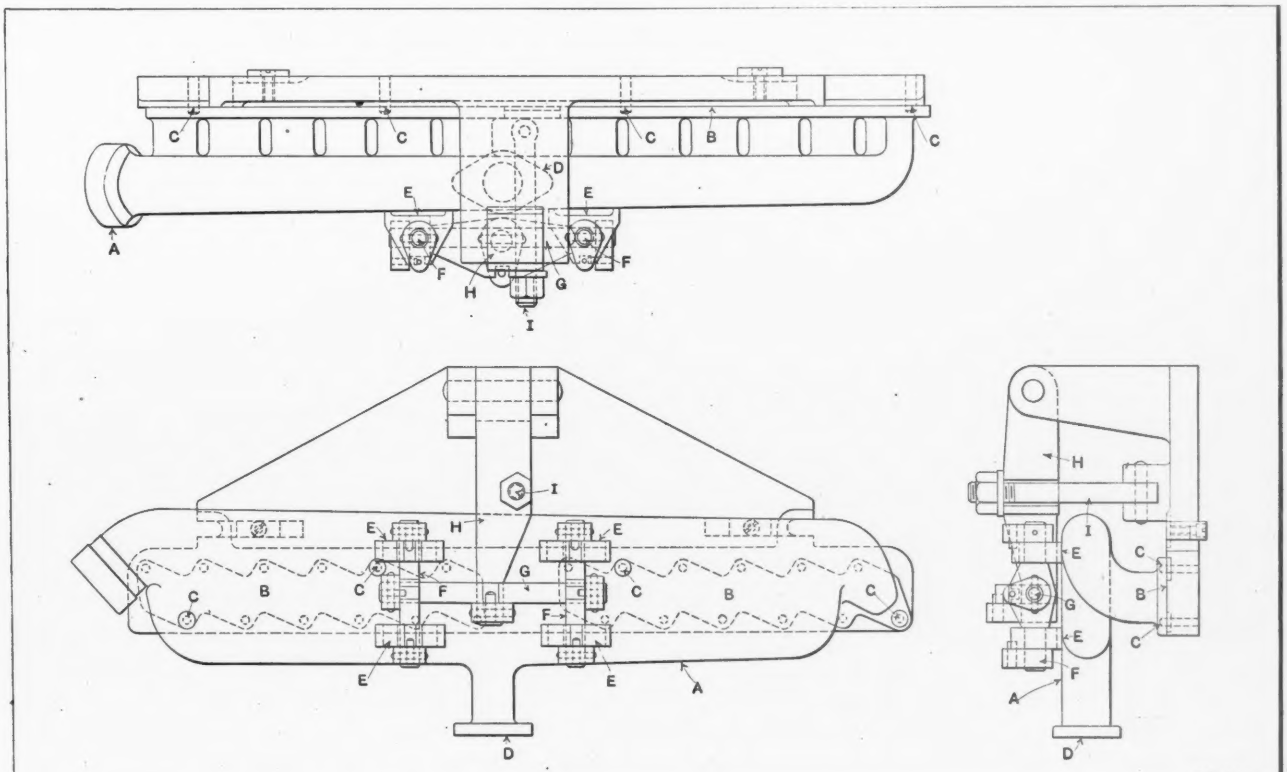


Fig. 6. Milling Machine Fixture with Equalizing Clamping Mechanism for holding Chandler Manifolds while milling the Carburetor Flange

ford, Ill., which is equipped with jigs of this type. It is used in the Chandler plant for drilling motor car steering arms. Both of the jigs used on this machine are of essentially the same design, except that they are arranged for drilling holes in opposite ends of the work, so that a description of one jig and the way in which it is used will suffice.

It will be seen that the jig is of the so-called "pump-handle" type. When handle *A* is depressed, it swings the outer ends of links *B* upward and through connections *C* provides for raising bar *D* against the tension of springs *E*. Connections *C* are threaded and furnished with lock-nuts above and below bar *D*, so that the position of this bar may be adjusted to suit the requirements of the work. With standard jigs of this type, the provision made for holding the work varies according to its form and the conditions under which the operation is performed. In the present instance, a hole is to be drilled in a cylindrical shaped boss at the end of the steering arm, and so the cup bushing principle can be satisfactorily utilized. Drill bushing *F* has a locating cup at its lower end beneath bar *D*, and there is a flat end bushing placed in the bed of the jig in line with the upper bushing *F*. When pump-handle *A* is pushed down, these two bushings are parted sufficiently so that the drilled work can be removed and the cylindrical boss at the end of the next forging can be put into place above the lower bushing, so that when handle *A* is released springs *E* will force bar *D* and bushing *F* down on the work, thus serving the double purpose of locating and clamping the work and of providing a guide bushing through which the drill operates.

With such a method of clamping, it is necessary to furnish a means for preventing the work from rotating while the drilling operation is in progress, and such means are provided by having the outer end of the forging engage a stud *G* set in the drilling machine table for that purpose. As previously mentioned, the hole in the opposite end of the steering arm forging is drilled in the other jig, the arrangement of which is essentially identical with the one that has just been described. The large hole is 51/64 inch in diameter by 1¼ inches deep, and the small hole is ⅝ inch in diameter by 1 inch deep. It will be seen that both spindles of the drilling machine are equipped with quick-change chucks, so that after the holes have been drilled tools may be changed to provide for the performance of reaming operations, the large hole being reamed to a diameter of 13/16 inch and the small hole being reamed to a taper. On this job the rate of production obtained is 225 steering arms in a nine-hour day.

Milling Inlet and Exhaust Port Flanges on Manifolds

On the cast-iron combination type of manifold used on the Chandler motor, the faces of the inlet and exhaust port flanges are finished by milling. This job constitutes a good example of the benefits that may result through making a desirable change in the method of setting up the work on a machine. A practice was formerly made of using fixtures that provided for holding two of the castings in a lengthwise position on the milling machine table, and when the work was milled in this way a feed movement of approximately 30 inches was required to complete the job. The planning department, in looking over this operation, saw that by reversing the position of the work and placing it transversely across the table of the milling machine, provision could be made for handling a casting with a feed movement of approximately 3½ inches.

A new fixture was made for handling the job with two castings set up to be milled simultaneously; and as a little space is required between the fixtures the actual feed movement is somewhat in excess of the 7 inches that would theoretically be required. The job is handled on a Brown & Sharpe plain miller shown in Fig. 4, and the method of procedure is to set up a casting in the fixture nearest to the cutters and then engage the feed movement. Before it is time for the cutter to start working on the second casting, the operator has had ample time to load it into the fixture, and following this procedure the idle time of both the machine and its operator is substantially reduced. It will be seen that the two inserted-tooth cutters have sufficient face width to reach across the two sets of flanges on each manifold, thus enabling the entire milling operation to be performed at one setting.

For locating these pieces for milling, the method of procedure is as follows: There are four plugs *A*, (see Figs. 4 and 5) that are raised or lowered by means of hand-screws *B* to provide for uniformly supporting the work from its rough cast surface. Before tightening up plugs *A*, the casting is dropped into place in the fixture, and one end is pushed into a V-block *C*, after which lever *D* is swung about its pivotal support to bring the V-block that is located at the opposite end of this lever from the handle into engagement with the end of the work. Next, two pivoted eccentric clamps, one of which is shown at *E* in Fig. 4 are brought into engagement with the back of the work to force it forward against the two plugs *F* at the front of the fixture, that support the thrust of the milling cutters; and, finally the casting is clamped down by tightening three straps *G*. In the performance of this operation the rate of production is 150 to 160 milled castings in a nine-hour day.

Milling Carburetor Flange on Manifolds

At *A* in Fig. 6 there is illustrated the manifold on which the intake and exhaust port flanges were milled while the work was set up in the fixture shown in Figs. 4 and 5; and the fixture illustrated in Fig. 6 is used for milling the carburetor flange on the same pieces. Bearing in mind that the operation just described is the first work done on these cast-iron castings, it will be obvious that the milled surfaces of the intake and exhaust port flanges will be utilized for locating the work. The finished faces of these flanges are secured against surface *B* on the fixture, and final location is accomplished by means of four pins *C* that enter holes drilled in the intake and exhaust port flanges. Held in this way the carburetor flange *D* is properly located for milling on a plain knee-type machine.

The interesting feature of this fixture is the arrangement of equalizing clamps that provides for obtaining a uniform grip on the rough cast surface of the back side of the manifold, to secure it in place ready for performing the milling operation. For this purpose there are four pivoted equalizers *E*, each of which is provided with two feet to grip the work. It will be evident that these equalizers are carried by crossbars *F*, which, in turn, are supported on a rod *G* carried by the pivoted arm *H*. After the manifold casting has been set up in the fixture, arm *H* is swung down so that the four equalizing clamps *E* come into contact with it; then the clamping bolt *I* is swung into position in a slot in the arm *H*, so that a slight amount of turning of the nut on this bolt provides the desired clamping effect. With the present system of supporting the clamping members *E*, adjustment is provided in three directions by means of pivotally supported connections between the arm *H* and the clamps *E*, so that ample compensation is provided for any irregularities in the castings.

* * *

PRINTING COSTS

The American Society of Mechanical Engineers has been investigating the increased cost of printing since 1914, and in November *Mechanical Engineering* are published some figures showing increases in costs in the publishing and printing business which have been greater than in practically any other industry. The figures that are quoted below from *Mechanical Engineering* show the percentages of increase since 1914 in the production of that journal, and of course are equally applicable to the production costs of a journal like MACHINERY:

Machine Composition	105	Paper	300
Hand Composition	218	Engravings (inch rate)	110
Presswork	170	Engravings (minimum sizes)	275
Binding	118		

Chart for Selecting Spiral Gears

By C. W. MAPES

THE selection of a pair of spiral gears to satisfy certain established requirements is not easily accomplished, mainly because an adequate grasp of the relation between the several factors involved cannot be easily acquired. The accompanying chart was developed to aid in selecting and calculating spiral gears with shafts at right angles to each other. It gives a graphical presentation of the conditions involved, and readily shows the influence that a change in one factor has on the others, thus making it possible to select the most suitable combination of gears with little labor and, in many cases, eliminate several trial calculations. The results read from the chart are necessarily approximate and should be checked by using formulas given in MACHINERY'S HANDBOOK in the section pertaining to spiral gears.

Description of Chart Construction

The chart is only suitable for gear combinations in which the tooth angle of the large gear is not greater than 45 degrees. However, as the ratio between the two gears of a combination increases above 1 to 1, the angle of the teeth in the large gear has an increasingly strong tendency to fall below 45 degrees, and so the range of the chart will satisfy nearly all cases. The center distance between two gears, the normal diametral pitch of their teeth, and the number of teeth in the small gear are not limited to the numbers and dimensions shown on the chart. The manner in which the scope of the chart is enlarged in this respect will be explained later. The horizontal lines represent the center distance in inches between the two gears of various sets. The plain vertical lines represent the angle of the teeth of the large gears, the width of each space representing ½ degree. The dotted vertical lines represent the number of teeth in the small gear. The vertical lines crossed by short oblique dashes, represent the normal diametral pitch of the gear teeth. The upper numbers at the top of the chart refer to the dashed lines while the lower ones refer to the dotted ones. The curves represent the ratio of gear sets and, as they are equally spaced vertically, odd ratios are proportional between the curves when measured in that direction.

Selecting Gear Combination by Use of Chart

In order to illustrate the use of the chart, assume that it is required to calculate a pair of spiral gears having a ratio of 3 to 1, of 10 normal diametral pitch, with an exact center distance of 1.875 inches, and with their shafts placed at right angles to each other. In addition, the conditions are such that the large gear must pass through a hole 2.25 inches in diameter and must fit on a 1-inch diameter shaft. These conditions necessitate that the pitch diameter be about 1.75 or 2 inches. In solving this problem, the first step is to locate the horizontal line on the chart representing a center distance of 1.875 inches, and follow it to its intersection with the dashed vertical line corresponding to 10 normal diametral pitch. From this intersection, lay a straightedge in the direction followed by the nearest diagonal line, intersecting the dotted vertical lines representing the number of teeth in the small gear.

At this point of the procedure, several trials must be made in order to decide what is the proper number of teeth to assume for the small gear. Trying six teeth, next follow the nearest horizontal line from the intersection of the straightedge with the six-tooth line, to the 3 to 1 ratio curve. From this point of intersection follow the nearest plain vertical line to the bottom of the chart, where the angle of the teeth of the large gear will be found to be about 19 degrees. As six teeth were selected for the small gear and as the ratio between the two gears of the combination is 3 to 1, the large gear will have 18 teeth. The pitch diameter of a gear having this number of teeth must now be determined, and this can be done by means of the following formula taken from MACHINERY'S HANDBOOK:

$$D = \frac{N}{P_n} \sec a$$

in which

D = pitch diameter of large gear;
N = number of teeth in large gear;
P_n = normal diametral pitch; and
a = exact spiral angle of teeth of large gear.

Substituting the known values in this formula,

$$D = \frac{18}{10} \times 1.0576 = 1.904 \text{ inches approx. pitch diameter}$$

This value for the pitch diameter is satisfactory according to the approximations previously made. Trying five teeth for the small gear and proceeding in the same manner, the large gear will be found too small, and with seven teeth, it will be found that the horizontal line from the intersection of the diagonal line with the vertical line representing seven teeth for the small gear falls below the 3 to 1 ratio curve. This fact shows that a combination of seven and twenty-one teeth would require either a greater center distance between the two gears or a finer pitch. These trials show that six teeth in the small gear and eighteen in the large one is the only combination which will fill the requirements.

The angle of the teeth in the large gear obtained by means of the chart should now be checked by the following equation given on page 674 in MACHINERY'S HANDBOOK:

$$R \sec a + \operatorname{cosec} a = \frac{2\,CP_n}{n} \qquad (1)$$

in which

R = ratio of number of teeth in large gear to number of teeth in small gear;
C = exact center distance between gears;
n = number of teeth in small gear;

and the remaining symbols represent the same elements as in the previous formula.

Substituting the values in this equation,

$$3 \times 1.0576 + 3.0715 = \frac{2 \times 1.875 \times 10}{6}$$

$$6.2443 = 6.25$$

This shows that the angle of the teeth in the large gear is slightly less than 19 degrees. Taking angle a as equal to 18 degrees 58 minutes gives a value of 6.2489 for the left side of the equation; and an angle of 18 degrees 57 minutes, gives the value of 6.2512. These calculations indicate that the exact angle of the teeth lies between 18 degrees 57 minutes and 18 degrees 58 minutes. Substituting this angle in the formula for exact pitch diameter,

$$D = \frac{18}{10} \times 1.05735 = 1.903 \text{ inches}$$

Cases when Chart Gives Two Different Angles for Teeth of Large Gear

In instances where the horizontal reference line from the intersection of the diagonal line with the tooth line crosses the required ratio curve at two points, either of these points may be used in determining the angle of the teeth of the

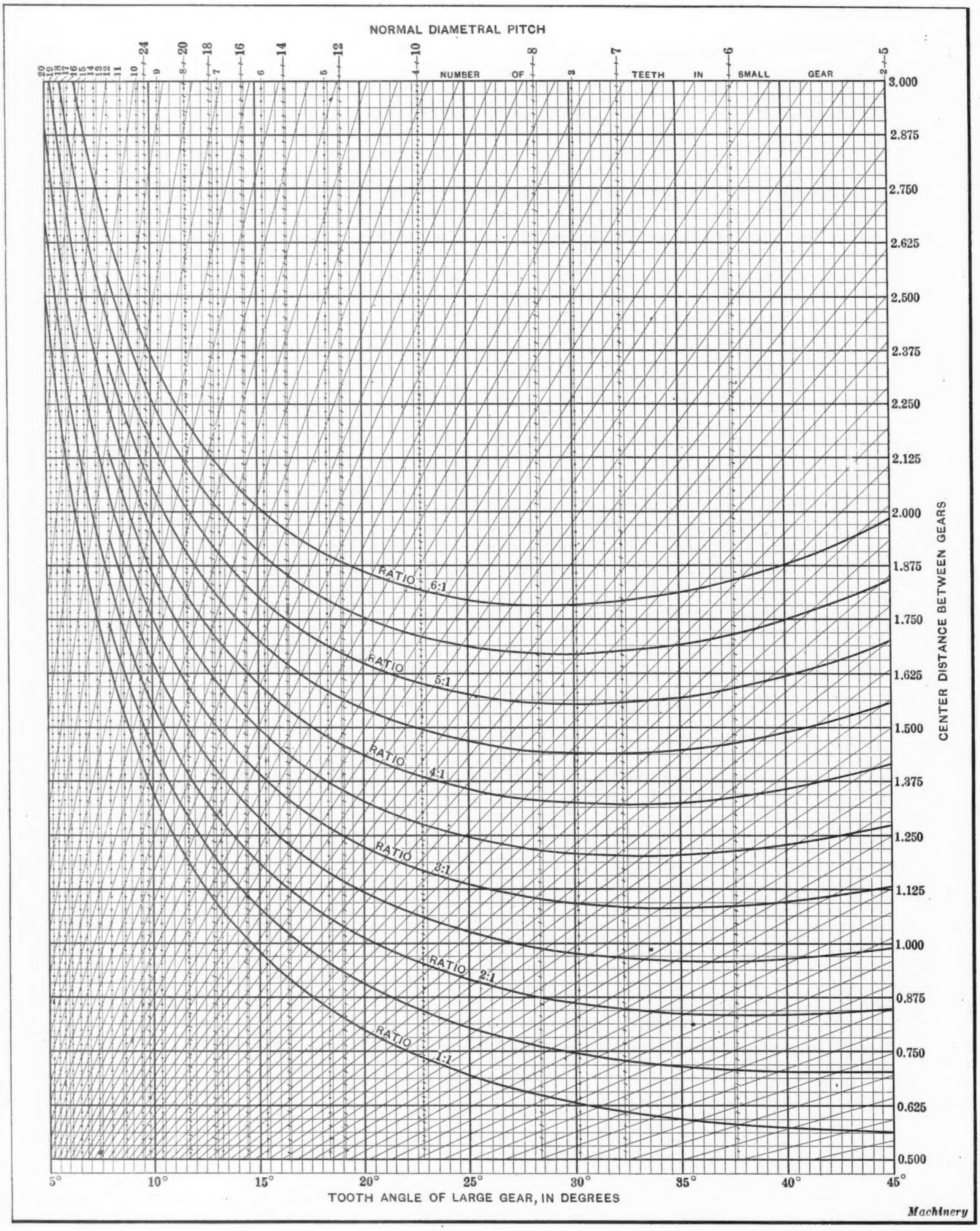


Chart for Selecting Spiral Gears having Shafts at Right Angles to Each Other

large gear. For instance, in a case where the center distance between two gears is 1.875 inches, the normal diametral pitch 10, the ratio 6 to 1, and the number of teeth of the small gear 4, it will be found that the horizontal line referred to crosses the 6 to 1 ratio at two points. The nearest vertical line to one point shows the tooth angle of the large gear to be about 19 degrees 22 minutes, while the nearest vertical line to the other point shows it to be about 39 degrees 50 minutes. The values obtained by substituting these angles in Equation (1) are almost identical, thus proving that either angle is suitable for the requirements given. It must be borne in mind, however, that the pitch diameter of the gear varies with the angle of the teeth, and so the proper angle to be selected depends upon this factor to some extent.

Enlarging Scope of Chart

Only a knowledge of the fundamental principles of spur gears is required to extend the use of the chart beyond the limits indicated by the figures for center distances and the numbers for normal diametral pitches and numbers of teeth of the small gear. The following rules hold good in this connection, provided the other factors remain unchanged:

Rule 1—The center distance between two gears varies inversely as the normal diametral pitch.

Rule 2—The number of teeth in the small gear varies directly as the center distance between two gears.

Rule 3—The number of teeth in the small gear varies directly as the normal diametral pitch.

As an example of the application of the first rule, for a set of 4 normal diametral pitch gears with a center distance of 4 inches, use the chart the same as for a center distance of 2 inches and for gears of 8 normal diametral pitch. As an example of the second rule, for a set of 10 normal diametral pitch gears having a center distance of 4 inches, use the chart the same as for a center distance of 2 inches but read double the number of teeth for the small gear indicated by the figures on the chart. As an example of the third rule, for a set of 32 normal diametral pitch gears having a center distance of 2 inches, use the chart the same as for a center distance of 2 inches and a normal diametral pitch of 16, but make the number of teeth 32/16 times, or double, that indicated by the figures.

* * *

FIXTURE FOR CASTELLATING NUTS ON A VERTICAL MILLING MACHINE

By WILLIAM OWEN

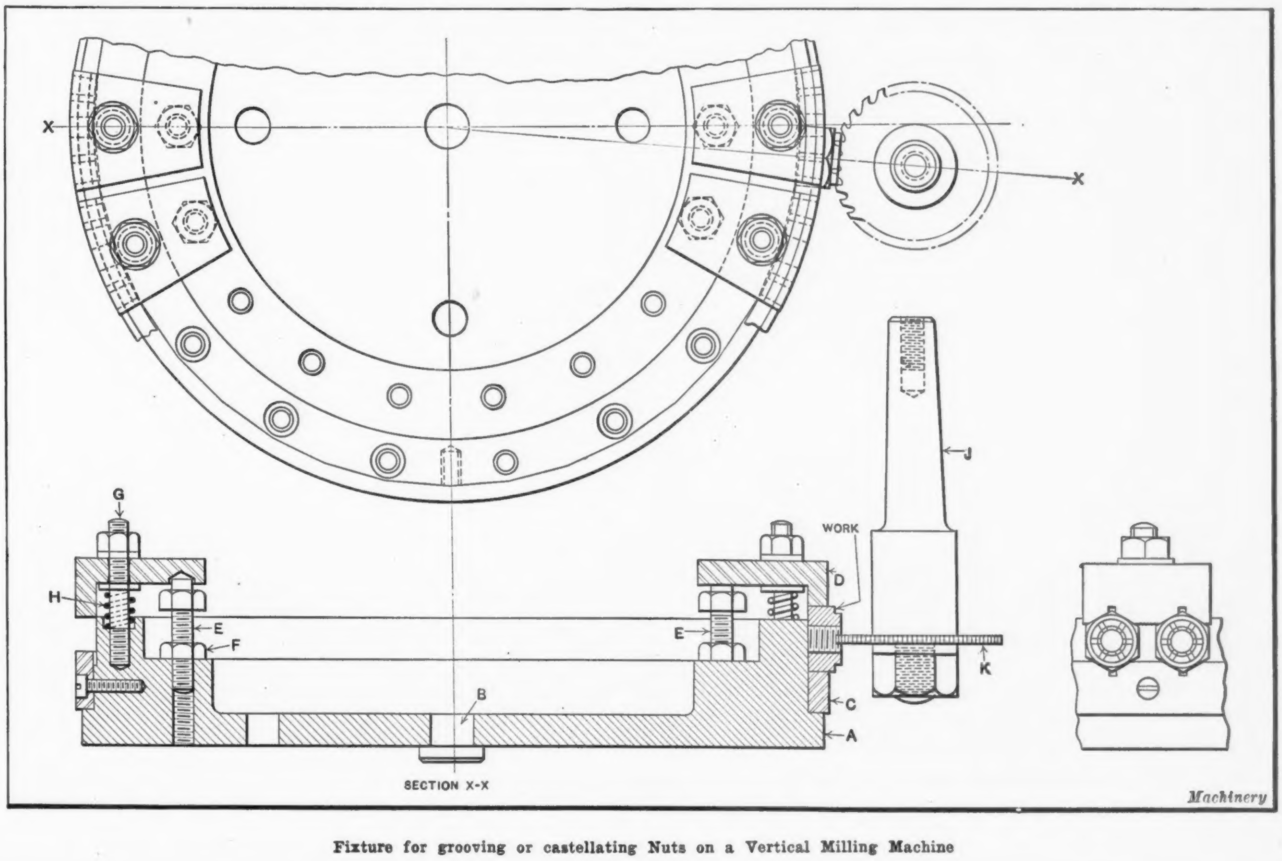
The grooving or castellating of nut faces without the aid of a special machine can be readily accomplished on a vertical milling machine equipped with a circular table, by employing the fixture shown in the illustration. This fixture was designed for handling nuts of a hexagonal shape, but by slight modifications it can be adapted for nuts of other shape or other parts on which it is desired to mill grooves in their faces. The fixture holds thirty-six nuts at one time, provision having been made for handling nuts of various sizes ranging from 5/8 to 1 3/8 inches.

The cast-iron body *A* is located on the table of the milling machine by means of plug *B*, and is secured to it by four T-bolts inserted through the holes in the base. The body is turned down around its periphery for the hardened V-ring *C*, which is pressed in place and attached to the body by four fillister-head machine screws. This ring is provided with thirty-six vees placed 10 degrees apart along its top surface for supporting the lower portions of the nuts to be machined, as shown in the partial end view. These vees have included angles to suit those between the flats of the work. Just above the top of ring *C*, thirty-six flats, also 10 degrees apart, are milled around the periphery of the body, their centers being in line with the centers of the vees in the ring. These flats support the backs of the nuts placed in the fixture, during the performance of the operation.

The upper portions of the nuts are held in vees provided in eighteen hardened clamps *D* which are placed equidistantly around the top of the fixture, there being two vees in each clamp. These clamps are held to various heights above ring *C*, by means of studs *E*, the height to which they are held depending upon the size of nuts being machined. Each of studs *E* can be raised or lowered by turning its hexagonal head, and after a clamp has been adjusted to the desired height, the stud is locked in place by means of nut *F*. The clamps are forced down on the work by tightening the nuts on studs *G*. A spring *H* is provided on each of these studs to force its corresponding clamp upward when the clamping nut is loosened.

After the clamps on the fixture have been set for handling a certain size of nut, arbor *J*, with cutter *K* attached, is placed in the spindle of the milling machine and secured there. The cutter is then set to the proper height in relation to the fixture so that it will cut grooves directly through the center of the nuts when the fixture is rotated. In order that these grooves will be cut to the correct depth, the fixture must also be set the proper distance away from the cutter.

The work of the operator consists of inserting and removing the nuts as the fixture revolves, and clamping and unclamping them by tightening and loosening the nuts on studs *G*, as previously described. When two grooves are milled across the nut in one direction, the position of the nut in the vees of ring *C* is shifted so that two more grooves are milled at an angle of 60 degrees to the first. The nut is then again replaced so that the final two grooves will be milled midway between those machined previously. A large production has been obtained by the use of the fixture described in the foregoing.



Fixture for grooving or castellating Nuts on a Vertical Milling Machine

SUGGESTION SYSTEM

A system that encourages employes to suggest improvements which they believe would increase production, promote safety, better working conditions, or lower production costs, is a paying proposition. The suggestion system here described has been used with excellent results by a well-known machine tool manufacturing company, and should prove a good type for almost any shop employing from one hundred to a thousand men. An organization of more than a thousand employes might well afford to adopt a more elaborate system.

Methods of Encouraging Suggestions

It may be said that the best method of encouraging suggestions is through an employe's shop magazine. In this magazine can be given a list of subjects upon which suggestions are desired. Another method of stimulating the desire to send in suggestions is to send letters by mail to the employe's home. When an employe gets an idea, either through the letter or some other source, he can go to one of the many suggestion boxes provided through the shop, and there obtain envelopes addressed to the president of the company and printed forms on which suggestions are to be written. These forms may be filled out at home or in the plant, as preferred. The employe signs his name, clock number, and department number at the bottom of the form, and mails the suggestion direct to the president.

Method of Handling Suggestions

These envelopes are never opened by anyone except the president. He reads the suggestion, and acknowledges its receipt in a friendly way, stating that the suggestion will be carefully considered and that decision as to its availability will be made as soon as possible. The president then writes the names of three department heads or executives on the back of the suggestion form, and turns the suggestion over to a stenographer who makes three copies, omitting the signature. The suggestion with the acknowledgment is then numbered and indexed, after which it is filed to await the replies from the three executives. As soon as the replies are received, they are attached to the original suggestion and turned over to the works manager. He reviews the answers, makes any required investigations, writes down his personal opinion of the suggestion, and then turns it over to the employment department to record. The suggestion then goes back to the president.

Reward for Suggestions

In most cases, the president will base his answer and the amount of the reward upon the three replies and the report of the works manager. Occasionally a suggestion is received which is referred to every department head. Again, a meeting may be called before a decision is made. The suggestion, when placed on the president's desk, is accompanied by a memorandum showing how many suggestions have been previously made by the employe. If it is the first suggestion, it receives special attention and the reward is usually more liberal than for later suggestions of the same value. In the plant in which this system was employed, it was found that only 40 per cent of the employes sent in suggestions during the first two and one-half years in which the system was in use. The employes composing the 40 per cent, however, did very well, having submitted 900 suggestions which averages a little better than one suggestion a day. A suggestion system, like many other systems or plans, is much easier to start than to keep up, and it requires some work to maintain the employes' interest. Almost any system will get results for the first two or three months, but if it is to become of permanent value, it must be carefully worked out. Care must be exercised in the handling of the suggestions, as one poorly handled suggestion may cause several employes to stop sending in suggestions. Almost every suggestion can be made of value. Probably only a small percentage of the suggestions will be found to be really good, while perhaps 75 per cent will be classed as ordinary. Of course, many suggestions that are actually foolish and a few of a peculiar nature that require diplomatic handling will be received.

Suggestion System Promotes Cooperation

The writer has in mind an instance of the tactful handling of an unacceptable suggestion. A suggestion was sent in, in which it was requested that the president arrange a new working schedule for the plant. The existing schedule was criticized, and an outline was given of a new working schedule which was claimed to be more favorable to the employes. After investigating the proposed plan, it was found that only about 15 per cent of the employes favored the idea. In replying to this suggestion, it was pointed out that the existing plans were made for the benefit of as large a percentage of the employes as possible, and that 85 per cent of the workers were better suited with the existing arrangement than they would be with the proposed schedule. With this explanation the employe could readily see why his proposed plan should not be adopted, and his sense of fairness would prompt him to tell others who had advocated the plan, why it was undesirable to make any change in the schedule.

A suggestion system is of great assistance to the employment department. It often enables the department to make promotions that will greatly benefit the company. Altogether, it serves as a means by which the employer can get into closer touch with his employes and thereby develop a spirit of cooperation throughout the plant. A. J. S.

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SCIENTIFIC ENGLAND AND THE METRIC SYSTEM

According to a statement received from the American Institute of Weights and Measures, 115 Broadway, New York City, there was prepared in the early part of 1920, but only recently made public, a very interesting and important report on the compulsory adoption of the metric system in the United Kingdom. This report was submitted by the metric committee appointed by the Joint Board of Scientific Societies, this board representing about fifty societies covering every field of science, art, and engineering. As stated in the preface note of the report, the committee was appointed to consider and report upon the advisability of compulsory adoption of the metric system of weights and measures by the United Kingdom. The report covers with appendices seventy printed pages. The first and basic recommendation made by the committee reads as follows:

1. That the British system of units of weights and measures be retained in general use in the United Kingdom; that no proposals for modification of these units with the object of improving their inter-relation be entertained; and that no new fundamental unit be established. In preference to any such alteration, the committee would recommend the whole-hearted adoption of the metric system.

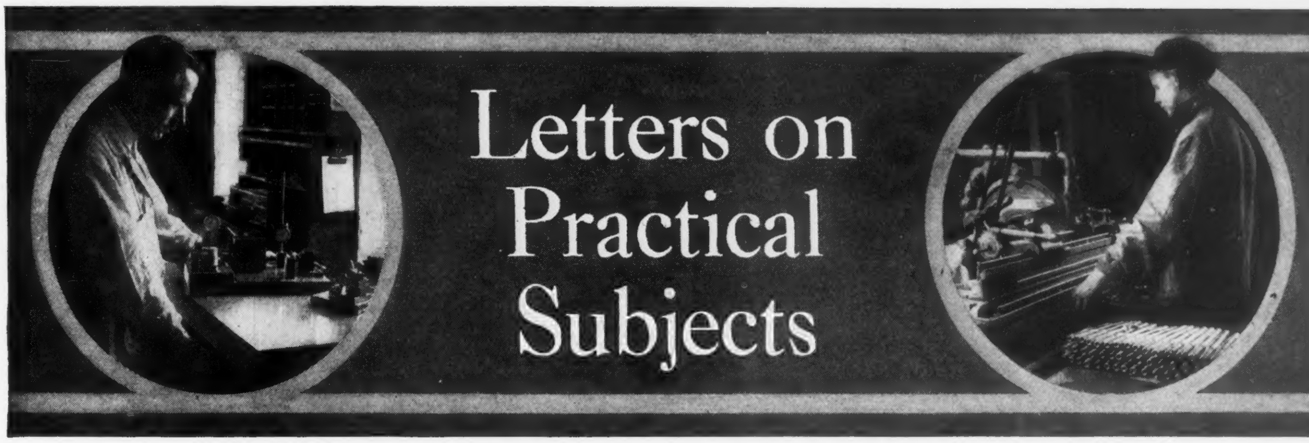
In the matter of simplification of the British system, the committee recommends the following:

Measure of Length—The abolition of the pole, furlong, and league; the limitation of the link and chain to use in the determination of area.

Measures of Weight—The abolition of the grain, dram, stone, quarter, and hundredweight of 112 pounds, and the complete abolition of apothecaries' weight.

Measures of Capacity—The use of the gallon as the general standard, with the customary subdivision into quarts and pints for retail use, but not otherwise; the abolition of the peck, bushel, quarter, chaldron, and barrel, and the substitution of measure by weight.

Measures of Areas—The abolition of the square rod or perch and the rood, all areas of land being in acres and decimals, or in square feet for small plots, and all other superficial measures being in square feet.

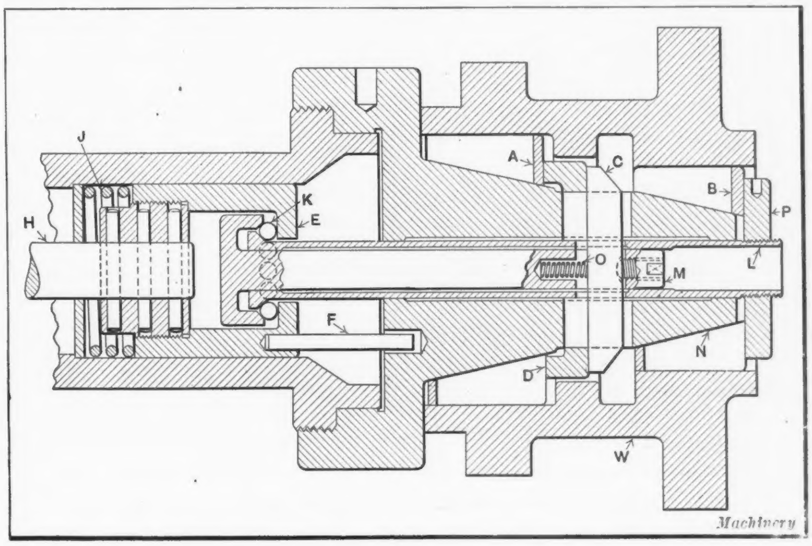


ADAPTER FOR LONG WORK

The adapter or expansion chuck here illustrated is shown applied to a Foster universal turret lathe, but may be used in connection with any screw machine or turret lathe that is furnished with an automatic chucking mechanism. The adapter in the present case is of the draw-back type, but with slight modifications in design it may be used in connection with the push-out type of chucking mechanism. It will be seen that this adapter employs the familiar expanding bushing idea and that the design provides especially for handling long work, which has been previously bored and on which there is a faced end that may be used as a locating surface when drawing the work against the arbor *N*.

The construction and operation of the adapter is as follows: The draw-rod *H*, which extends through the machine spindle and is operated by the automatic chucking mechanism, is pinned to a head which screws into one end of plunger *E*. The opposite end of plunger *E* and the angular surfaces of sleeve *L* and rod *M* form a housing for balls *K*, so that when the plunger is drawn back, the pressure will be equally distributed on these surfaces of the rod and sleeve, through the medium of the ball bearings. Rod *M* extends through sleeve *L* in which it is free to operate, and both these members are slotted to accommodate the bar *C*. The tapered arbor *N*, which is screwed to the nose of the spindle, contains an elongated slot in which this bar *C* operates.

There are two split bushings *A* and *B* which are expanded on the two tapers of the arbor when the adapter is in use, by rod *H* being moved axially to the left. It will be seen that there is a washer *D* which is forced against the end of bushing *A* when bar *C* is brought in contact with it, and on the threaded end of sleeve *L* there is another washer *P* which acts on bushing *B*, so that by drawing rod *H* to the rear, the two washers force the split bushings on the tapered arbor and thus expand them. The adapter is shown expanded, holding the work *W* against the face of the tapered arbor. Spring *J*, enclosed in the spindle, releases the work by returning the expanded bushings to their inoperative positions as soon as the chucking mechanism has functioned. Simultaneously with the release of the work, the spring *O* in the end of rod *M* expands, keeping the bar *C* in contact with the set-screw against which it bears.



Sectional View of Adapter applied to Turret Lathe Spindle

By suitable modification in the size of the bushings to suit the requirements of the particular piece of work for which the adapter is to be used, this device is applicable to a wide range of work. Pin *F* is provided to prevent the plunger from turning while the draw-rod is being turned.

Elkhart, Ind. I. F. YEOMAN

TRAINING TOOLMAKERS FOR TOOL DESIGNERS

It is a source of annoyance to many toolmakers to receive some of the drawings that they are compelled to follow in making tools, because in many instances the men in the shop know more about the tool to be made than the man who made the drawing. The usual way to obtain a tool designer is to advertise for him, and frequently the best kind of man is not obtained in that manner. There is some very good material available in almost every large plant in the mechanical line from which first-class tool designers could be made. This material in many cases is not used and, instead, great effort is put forth to secure ready-made tool designers from the outside.

Every toolmaker will not make a good tool designer, but it is certain that the more shop experience a good tool designer has, the better designer he is. It does not take long to make a good tool designer out of a toolmaker with ideas and ability, provided he is of the type that is willing to learn. When a man is found in the shop who is quick to learn and is a good all-around mechanic, it is a good plan to try him out in the drafting-room. He is likely to make a good tool designer. If he has made good in the shop, there is at least an even chance that he will make good in the drafting-room. With a shop full of good toolmakers that could be tested out and from which selections may be made for designers, why should unknown outside men be brought in for trial?

It is believed that it will pay the employer to put some of his toolmakers into the drafting-room and train them even if they have to stay at the board learning for the first six months. It has been suggested that in order to protect himself, the employer might have some kind of contract drawn up for a given period of time. The selection should be based upon the man's experience, his willingness to learn, his loyalty and his ability

to see things mentally. Generally speaking, a good toolmaker who has had an opportunity to spend a period in the production department, so as to get a good idea of the necessary essentials of jigs and fixtures, will in a short time make a good and dependable tool designer. If the large plants in the country would use this method of training tool designers, it would be possible to eliminate a great many men who are now engaged in this work but who are not fitted for it by experience and training, and more efficient designers would thus be obtained.

Jack Homewood
Ontario, Cal.

CAM MILLING ATTACHMENT

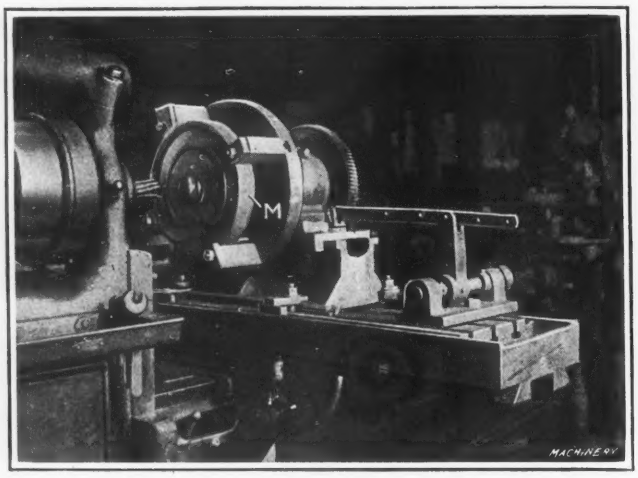


Fig. 1. Cam Milling Attachment mounted on Milling Machine

The attachment shown in the accompanying illustrations has been used successfully for a number of years on a horizontal milling machine for milling cams such as the one shown at *M*, Fig. 1. In this illustration the attachment is shown in position on the milling machine table as it appears when in operation. The method of imparting motion to the work in such a way that the required contour will be given the cam, is shown in Fig. 2.

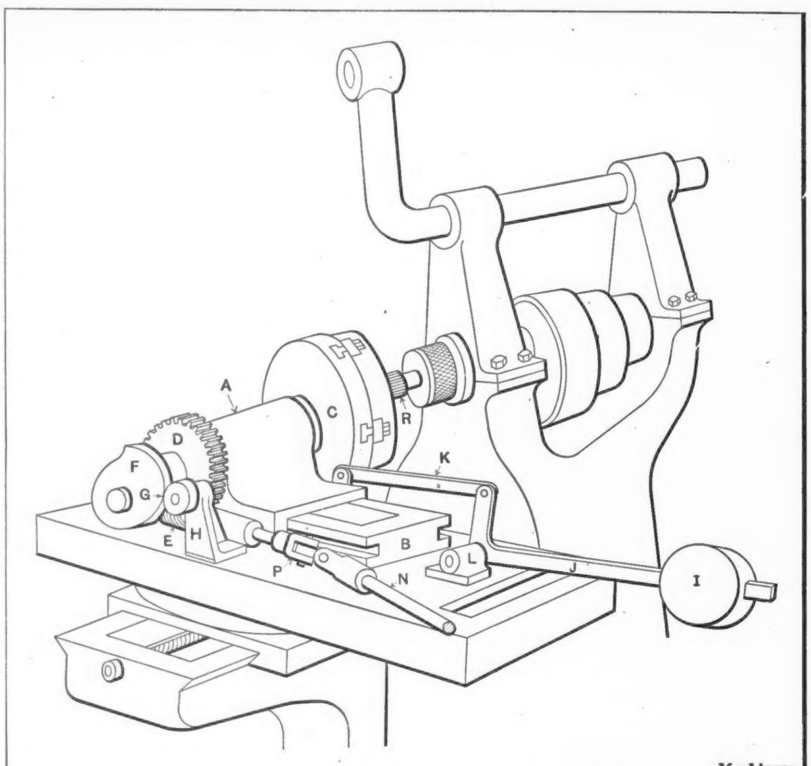


Fig. 2. Illustration showing Principle on which the Cam Milling Attachment operates

Referring to Fig. 2, *A* is the bearing or headstock casting, which is mounted on slide *B*. The chuck *C* has four jaws and is mounted on one end of the work-spindle, which is rotated by means of worm *E* and worm-wheel *D* through shaft *N*. Shaft *N* is driven from the feed-box, and is provided with a universal joint *P* as shown. The former, or master cam *F*, corresponds in outline to the cam groove required in the plate cam which is to be milled. The weight *I*, acting on head *A* through bellcrank lever *J* and link *K*, keeps former *F* in contact with roller *G*, which is mounted on a fixed bracket *H*. When the machine is in operation, the cam being cut is rotated against the cutter *R*, which is held in the milling machine spindle. In addition to the rotary motion, it is evident that the work-spindle moves back and forth over slide *B* in accordance with the sliding motion transmitted by former *F*. The contour of the groove milled in the cam face is thus made to conform to the contour of the former cam *F*.

Fig. 3 is a sectional view of the milling attachment, which shows the work-holding spindle and the important structural details of the attachment. The plate cam shown in Fig. 1 has cam grooves on both of its faces. In order to mill these grooves, it was, of course, necessary to make suitable provision for reversing the piece in the chuck. This necessitated designing the spindle in such a way that it could be adjusted longitudinally so that it would extend through the full length of the cam hub when the cam was reversed or placed in the chuck in the position indicated by the dotted lines at *N*. It will be noticed that the chuck jaws consist of two pieces *A* and *B* and that the parts *A* are formed to fit the work. The jaws are employed to clamp the work against the face of the chuck, and are not intended for use in centering the work, as that is accomplished by the spindle, which is made a close fit for the hole in the hub of the cam. Former or master cams which are interchangeable on the spindle are provided for use in milling cams that have different contours.

W. C. Steuart
Baltimore, Md.

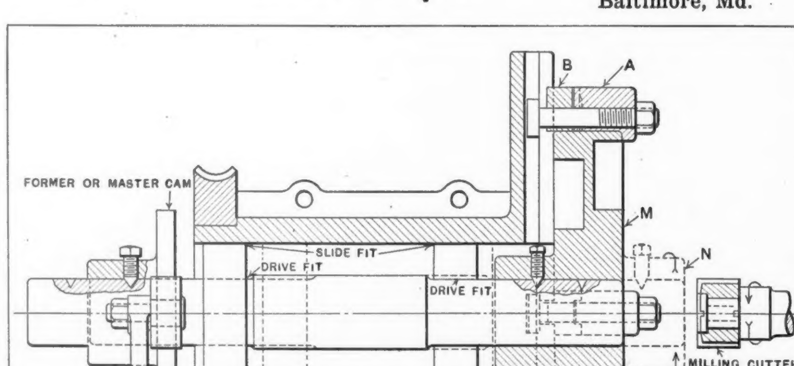


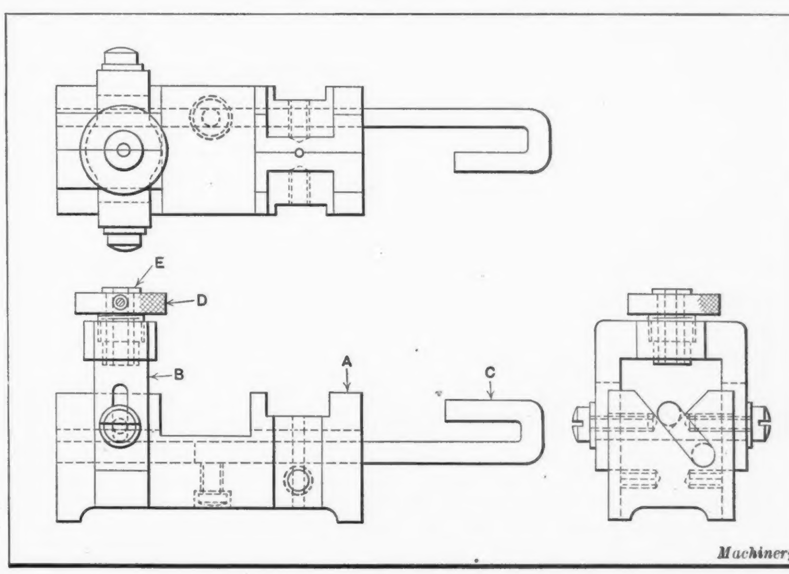
Fig. 3. Sectional View through Work-holding Spindle showing Important Details of Construction

ADJUSTABLE DRILL JIG FOR SMALL ROUND STOCK

The drilling of cross-holes in small studs, pins, shafts, tubes, etc., presents a problem in shops where the quantity of work does not warrant the outlay of much money for drill jigs. When the tolerances specified are taken into consideration, it is obvious that this work demands some adequate method of tooling that will permit operations to be performed accurately and economically. The accompanying illustration shows a jig which has been designed to meet such conditions on work ranging from 1/8 to 5/8 inch in diameter and of various lengths.

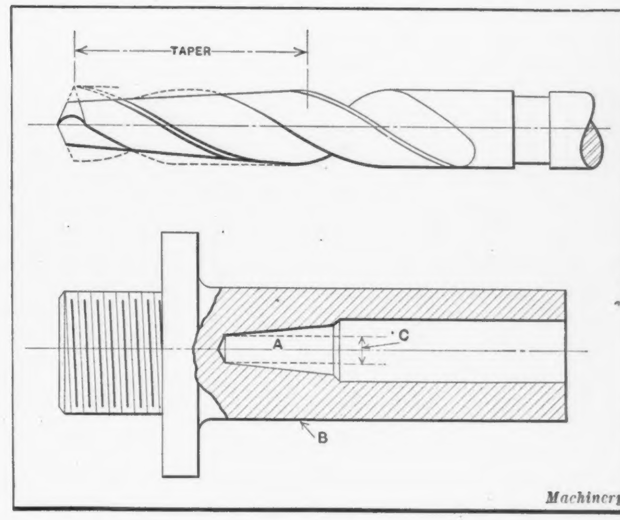
It will be seen that base *A* is provided with a raised section at the top of each end, which has a V-groove running in a longitudinal direction in which the work is placed. On each side of the ends of the base there is a slot of a sufficient width to accommodate yoke *B*. The latter is attached to base *A* by means of two fillister-head machine screws which fit in tapped holes in the slots of the base. In the slot at the left end of the base, the tapped holes are near the top, and when the yoke is placed at this end, the jig is adapted for the larger sizes of work. The tapped holes in the right-end slots are near the bottom of the base, and when the yoke is fastened in these slots, the jig is arranged for handling the smaller sizes.

The work is located longitudinally in the jig by means of stop *C* which can be secured in various positions to suit the distance a hole is to be drilled from the end of a part, by means of the fillister-head machine screw contained in the bottom of the base. The work is clamped in the jig by the knurled and threaded sleeve *D*, which is screwed down on it. This sleeve contains the drill bushing *E* and has a ground cylindrical surface at its lower end to guide it accurately while it is being screwed into the yoke. Drill bushing *E* is removable and made for various drill sizes.



Jig for drilling Holes in Different Sizes of Small Round Stock of Various Lengths

Brooklyn, N. Y. WILLIAM J. GOURLEY

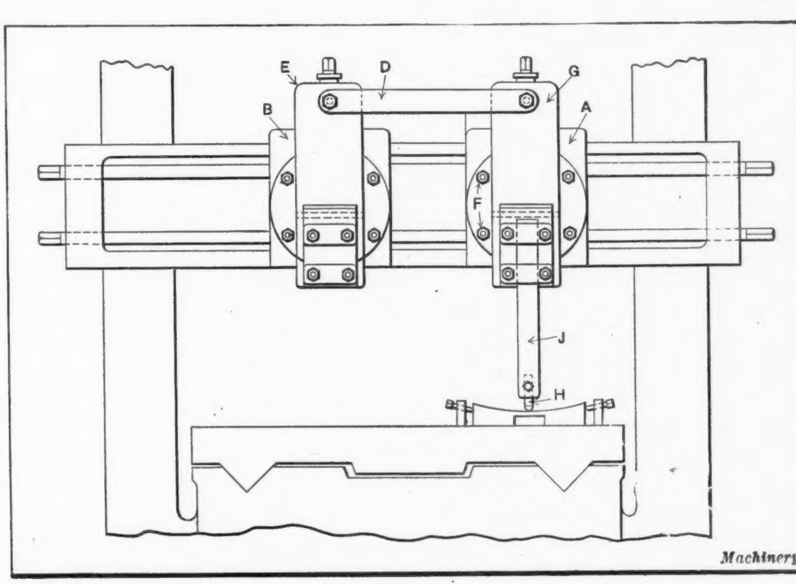


Reamer made from Twist Drill for reaming Hole A

TAPER REAMER MADE FROM TWIST DRILL

The accompanying illustration shows how a standard 5/16-inch diameter high-speed steel twist drill was ground down to a taper of 3/8 inch per foot, and properly relieved for the purpose of reaming out hole *A* in the hard cast-iron step bearing *B*. It was found that a twist drill with the taper ground as shown would cut faster than the best standard reamer obtainable, and that it would produce a good finish and stand up well in the hands of unskilled workmen. A straight drill was, of course, employed to drill out the hole to the size indicated by the dotted lines at *C* in the illustration before using the tapered drill to produce the desired tapered form.

Honesdale, Pa. W. BURR BENNETT



Equipment provided on Double-head Planer to adapt it for machining Circular Surfaces

MACHINING CIRCULAR SURFACES ON THE PLANER

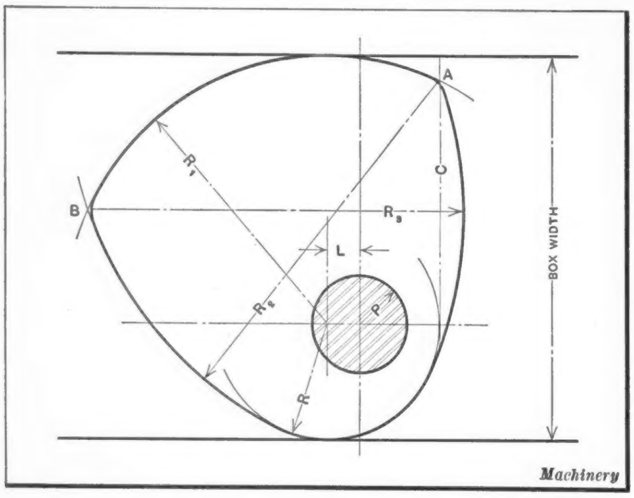
A simple arrangement permitting circular surfaces to be planed, which can be applied to any double-head planer, is shown diagrammatically in the accompanying illustration. Saddle *A* is clamped stationary on the cross-rail, while saddle *B* can be fed along the cross-rail in the customary manner. Slide *E* is clamped in a vertical position on saddle *B* and is connected to slide *G* by means of rod *D*, the latter being attached to the slides by machine screws. The slide clamp-nuts *F* are loosened just sufficiently to permit slide *G* to swivel when a slight pressure or pull is applied at its upper end. It will be seen that tool *H* is held in a special holder *J*, which should be rugged enough to permit operations to be performed without chattering.

In planing a circular surface, when saddle *B* is fed along the cross-rail, rod *D* causes slide *G*, holder *J* and tool *H* to swivel, so that the cutting edge of tool *H* travels in the desired arc. The radius to which the circular surface is planed depends upon the distance from the cutting edge of the tool to the center about which slide *G* swivels. The writer has seen surfaces having a radius of 3 feet planed successfully with this equipment. The length of rod *D* is governed by the width of the planer and the width of the work.

Ilion, N. Y. D. R. GALLAGHER

LAYING OUT A BOX CAM

In the following, a description is given of an accurate method of laying out a box cam of the type used extensively in jig and fixture constructions, so that the cam will be in



Method of laying out a Box Cam Quickly and Accurately

contact with both sides of the box during the complete revolution of the pin on which the cam is mounted. Although this cam is a standard type, the writer has never seen any instructions that would enable a draftsman to lay one out to suit various conditions which may arise. The following method applies to a cam of any size and lead, and the layout can be accomplished within a few minutes.

First establish the horizontal and vertical center lines about which the cam is to rotate, and then determine the horizontal distance *L* that the contact points of the cam are to be ahead of the center about which the cam rotates. Next lay out the pin outline of which *P* is the radius, after which draw an arc of radius *R* and one of radius R_1, to suit the width of the opening in which the cam is to fit. Next, erect vertical line *C* tangent to the arc of radius *R* until it intersects the arc of radius R_1 at *A*. From this point of intersection draw an arc of radius R_2 tangent to the arc of radius *R*, intersecting the arc of radius R_1 at *B*. Finally, from intersection *B*, strike an arc of radius R_3 tangent to the arc of radius *R*. The last arc will also meet intersection *A*.

It is evident that radii R_2 and R_3 are limited by radii *R* and R_1. With a cam of this construction, there will be no play between the box and the cam at any time, and the fixture clamp may be operated either by the box, using a stationary cam pin, or by the cam pin, using a stationary box.

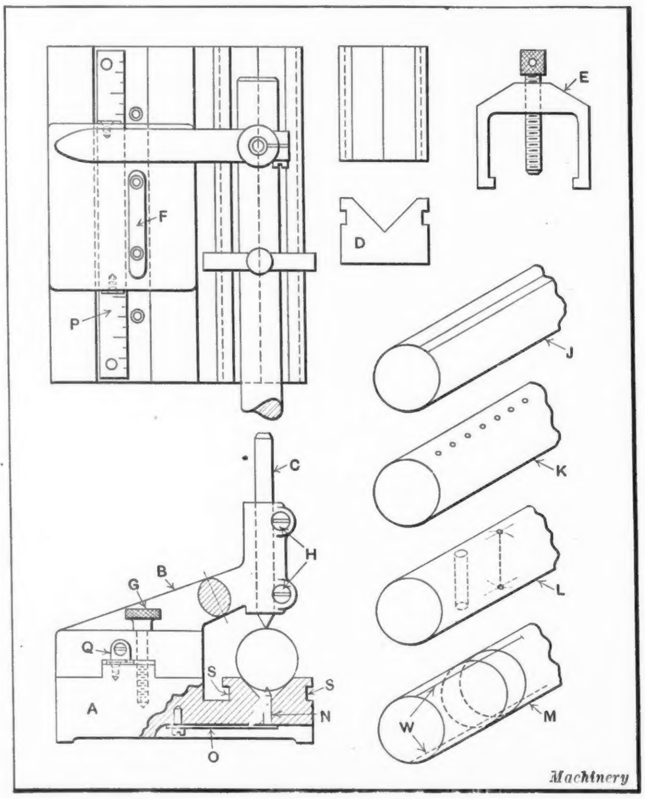
Bound Brook, N. J. OSCAR J. NOLLET

A PUNCH-MARKING AND SCRIBING FIXTURE

The accompanying illustration shows a useful fixture for the toolmaker or anyone who has considerable laying out to do on round stock. It consists of a cast-iron base *A*, having a vee for holding the work, and a cast-iron bracket *B* for holding the punch or scriber *C*, also an auxiliary V-block *D* for supporting the end of a long piece of work. At each side of the vee are grooves *S* for the hold-down clamps *E*, which may be forged to shape or cut from a solid steel plate. The bracket slides on the base, being guided by the raised portion or tongue on the latter. It has a long slot *F* through which a clamp screw *G* enters any one of a series of tapped holes in the base, for such work as requires clamping the bracket to the base. The hole for the punch or scriber is accurately drilled and reamed vertically on a line with the bottom of the vee in the base. A split boss and two clamp-screws *H* take up any play between the punch and its guide.

For the purpose of marking round stock diametrically opposite for drilling as indicated at *L*, a small hardened and pointed stud *N* is set into the bottom of the vee as shown, and held in place by a flat spring *O* working in a planed or milled groove in the bottom of the base. In doing work of this kind the bracket is first clamped so that the points of the punch and stud are in line; then the work is inserted and a mark made with the punch. The work is then reversed and placed so that the lower point enters the punch mark; then the upper side is punched, thus locating the two marks opposite each other. Another way would be to drill the work in place in the fixture after marking the upper side. When using this method the work would be left clamped in place and the bracket removed. The base and work would then be placed on the drilling machine table and the hole drilled through. The lower aligning point would not, of course, be used, but a clearance hole for the drill would be drilled through base *A* at any convenient place in the bottom of the vee.

It is sometimes necessary to mark off a series of equally spaced points as indicated at *K*, for slot drilling. To facilitate such work the fixture is provided with a thin flat steel rule *P* attached to the top of the slide and a steel spacing



Marking and Scribing Fixture, and Examples of Work for which the Device is adapted

plate *Q* at each end of the bracket casting, so that the bracket may be moved along the work a known distance after a prick-mark is made.

Locating lines for keyways as shown at *J*, may also be scribed by clamping the work and sliding the bracket and scriber over it, or in the case of a long bar, the auxiliary V-block would be clamped to the bar, which would then be pushed under the bracket, the bracket in this case being clamped to the base. Circumferential lines as indicated at

M may be scribed by rotating the work against a stop. Lines *W* can be scribed diametrically opposite by making use of the lower point and the auxiliary V-block.

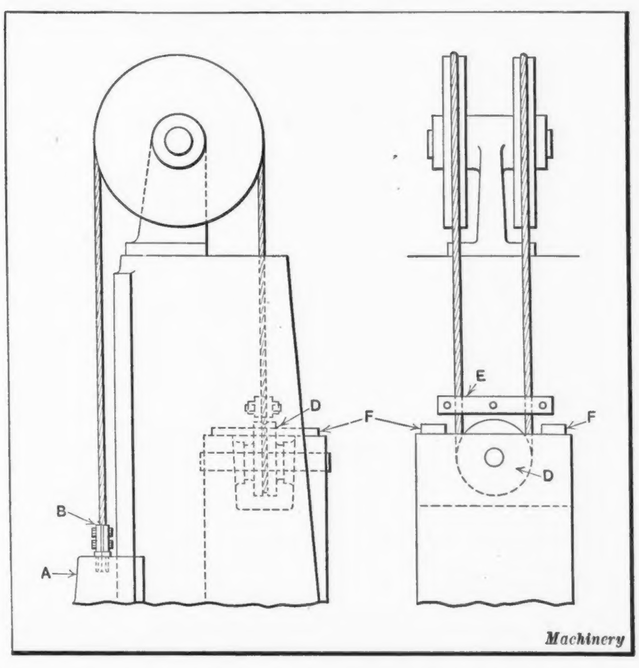
The bracket, when removed bodily from the base, makes a very convenient fixture for use in marking a surface plate or flat work, as it holds the punch perpendicular to the surface. It can also be used for scribing lines by sliding the bracket along against a straightedge.

Oakland, Cal. H. H. PARKER

SAFETY ARRANGEMENTS FOR MACHINE TOOL COUNTERWEIGHTS

In the article describing various applications of counterweights to machine tools, which appeared in the October number of MACHINERY, mention was made of the damage which might be caused by breakage of the chain attaching the counterweight to the spindle slide of the machine, and an illustration was presented of an arrangement for automatically locking the spindle slide in the event of such an occurrence. The writer knows of several other safety devices which may be of interest. In attaching a counterweight to the tool-slides of vertical planers and long-stroke slotting machines, it has been the practice of some manufacturers to employ two parallel chains for the purpose, each of the chains being sufficiently strong to support the counterweight and the tool-slide if the other chain should become broken. In other designs, wire ropes are substituted for the chains, the ropes being spliced at each end and provided with eyes that are attached to the tool-slide and counterweight in much the same way as the chains.

A method of attaching the counterweight to the tool-slide by means of a single wire rope is shown in the illustration. In this case, both ends of the rope are attached to the tool-

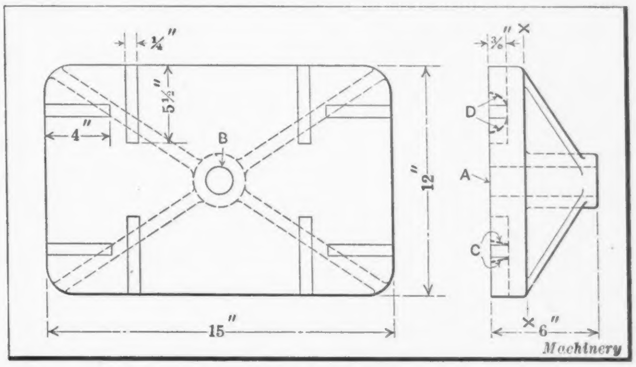


Safety Method of attaching Counterweight to Tool-slide

slide *A* by means of clamps *B* which are screwed to the slide. The rope is held by vees cut in these clamps and gripped securely by four bolts. It passes over the two pulleys at the top of the column and around pulley *D* which is mounted at the top of the counterweight. Just above pulley *D*, two bars *E* are clamped tightly on the rope. Each half of the rope supports one-half the load, but the rope must be of sufficient strength so that the entire load can be supported by either section in case one breaks. If this should happen, bars *E* would come in contact with either of bars *F*, preventing the rope from slipping around pulley *D* and so causing the weight to be supported by the unbroken half of the rope. Provision against such an occurrence may seem a needless precaution in view of the fact that wire rope is not subject to sudden fracture without warning, but the cost of the application is little, and is a small enough insurance to pay against even the remote chance of rope breakage. H. T. M.

HOW SMALL CHANGES IN DESIGN FACILITATE MOLDING

Proper consideration of the purpose for which a casting is intended and of molding methods should always be given by the draftsman and patternmaker when making the drawing and pattern. A little forethought often reveals cases in which slight alterations in the design of a part will make the construction of the pattern and the molding operation much simpler. A concrete example of such an instance will



Drawing of Side Plate for Block used in winding Electric Generator and Motor Fields

be given. The illustration shows the drawing of an iron side-plate casting for a block used in winding electric generator and motor fields. This drawing was produced from a rough sketch furnished by an electrician, who specified that surface *A* and hole *B* were to be finished, and that the slots in surface *A* were to be cast clean so that no machine or hand work on them would be necessary.

The pattern made from this drawing was split along the line *X—X*, it being the idea of the patternmaker that the hub and rib section should be molded in the cope of the flask, and the plate section in the drag. Slots were cut on the pattern so that green sand could be used to form the projections in the mold required for obtaining the slots in the casting. As a matter of fact, the slots were too narrow for molding in green sand, so the molder placed the entire pattern in the drag and made the parting line of the mold along face *A*. In order to produce the slots, cores of proper size were cut from a stock slab core and fitted into the slots on the pattern. When the sand in the cope had been rammed and the cope was lifted from the drag for the purpose of removing the pattern from the mold, it was found that the cores adhered firmly to the cope. Thus, when the cope was replaced on the drag, a satisfactory mold was obtained.

The purpose for which the casting was employed did not require the sides of the slots to be parallel, and they could just as well have been tapered as indicated by the heavy dotted line at *C*, or rounded as shown at *D*. By making the slots either way, cores for their production would have been unnecessary, as the green sand of the cope could have been rammed into the slots on the pattern and the projections thus formed would not have been destroyed when the cope was lifted in order to remove the pattern from the drag. The construction of the pattern also would have been much simpler, as it could have been of the solid type. Making the slots as shown at *D* would mean even less work for the patternmaker than making them as shown at *C*, because in the former case the slots could be made by the use of gouges. From the foregoing it will be apparent that the more knowledge a draftsman or a patternmaker has of the molding trade, the more efficient he will be in his line of work.

Kenosha, Wis. M. E. DUGGAN

FORMULA FOR FINDING ROOT WIDTH OF SPLINEWAYS

For milling splineways in shafting and similar work, a milling cutter of the form shown in the partial section view of the accompanying illustration may be used. The accuracy of the finished work as regards width of cut depends

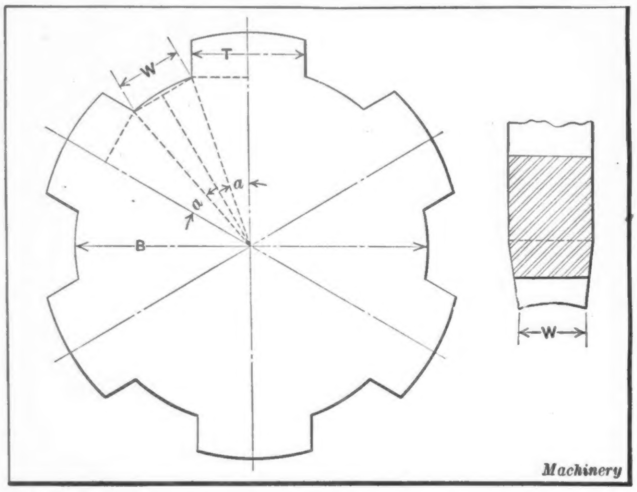


Diagram used in calculating Width of Cutting Edge of Spline Groove Milling Cutters; also Partial Section View showing Type of Cutter

upon the width W of the cutting edge of the cutter. This dimension may be computed by using the following formula:

$$\text{Sin}\left(\frac{\dfrac{360\text{ deg.}}{N} - 2a}{2}\right) \times B = W$$

in which N = number of splines;

B = diameter of body or of the shafting at the root of the splineway.

Angle a must, of course, first be computed, as follows:

$$\text{Sin } a = \frac{T}{2} \div \frac{B}{2} \text{ or}$$

$$\text{Sin } a = \frac{T}{B}$$

where T = width of spline;

B = diameter at the root of splineway.

This formula has been used frequently by the writer in connection with broach design, but it is capable of a more general application, and for that reason may be of considerable value to other readers of MACHINERY. If the splines are to be ground on the sides, suitable deduction must be made from dimension W to leave sufficient stock for grinding.

New London, Conn. C. H. BRIGGS

CHART FOR DETERMINING PRESSURE FOR FORCED FITS

The accompanying chart was developed to facilitate the determination of the approximate pressure in tons required to assemble parts having a forced fit. It is based upon data given in MACHINERY'S HANDBOOK on pages 883 to 885, inclusive. The formula given on page 885 for finding the pressure is comparatively simple; however, when a considerable number of calculations of this nature must be made, much time can be saved by using the chart, and the values will be found to be sufficiently close for ordinary practice. Referring to the chart, scale D represents the diameter of the work in inches; scale L, the length of the work in inches; scale P, the pressure in tons; and scale A, the fit allowance in decimals of an inch. Scale F is based upon the table of pressure factors given on page 884 in the HANDBOOK, but instead of the actual factors being denoted on the scale, the corresponding diameters are given in inches. This makes the use of the chart more convenient, as otherwise it would be necessary to refer to the HANDBOOK in order to find the proper factors to be used with a given diameter. These pressure factors are based upon the assumption that the diameter of the hub is twice that of the bore, that the shaft is machine steel, and that the hub is cast iron.

In order to illustrate the use of the chart, assume that it is desired to find the pressure required for assembling a flywheel having a bore 5 inches in diameter and a hub 5 inches long, on a shaft, and that the fit allowance is 0.002 inch. The dotted lines on the chart show the manner in which this example is solved: A straightedge is first laid across the chart connecting the graduation marked 5 on scale D with a similar graduation on scale F. Then from the intersection of this line with the reference line X, the straightedge is laid to the graduation marked 5 on scale L. From the intersection of this line with the reference scale Y, the straightedge is next laid to the graduation on scale A that denotes the fit allowance given in the example, or 0.002 inch. The required pressure will then be found by observing the point of intersection of the straightedge with scale P. This is shown on the chart to be about 8 tons; actual calculation by means of the formula on which the chart is

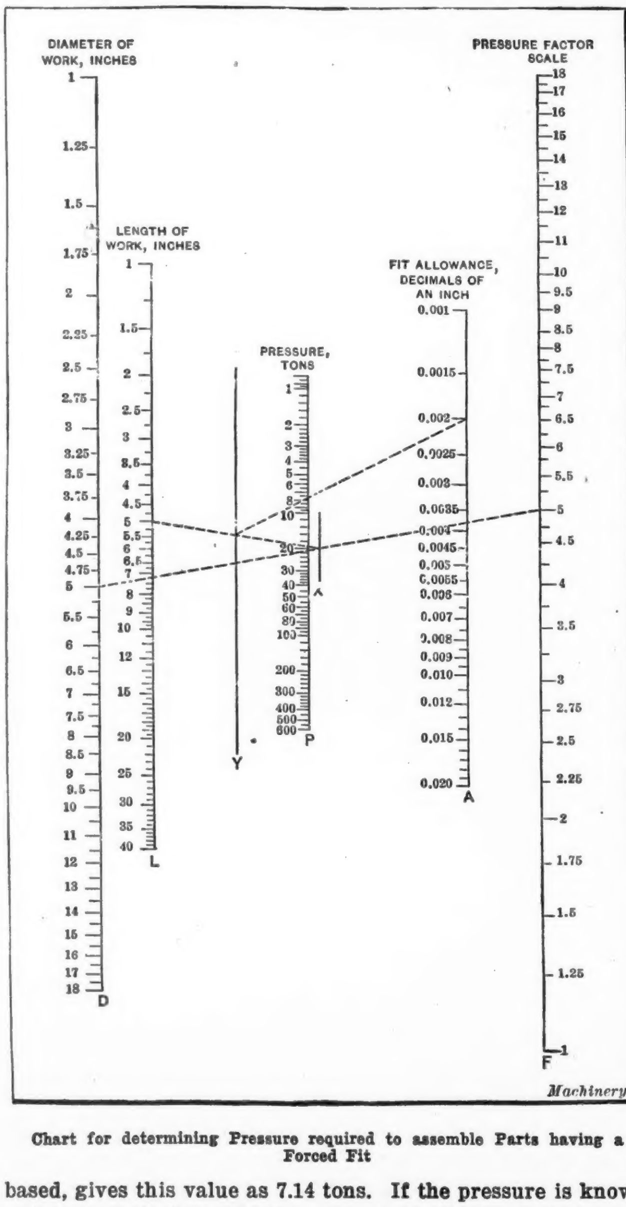


Chart for determining Pressure required to assemble Parts having a Forced Fit

based, gives this value as 7.14 tons. If the pressure is known and it is desired to find the amount of allowance that could safely be employed on the parts to be assembled by the given pressure, the same procedure would be followed with the exception that in the last step, the straightedge would be placed on the graduation on scale P rather than scale A, and the result read on scale A.

North Plainfield, N. J. J. B. CONWAY

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

CALCULATING DISTANCES TO CENTER OF RADIUS

H. W. K.—Will you please show me how to find distances x and y in the illustration, from the dimensions given?

A.—In the right-angled triangle AOB it is obvious that

$$x^2 = (8-2)^2 - (8-y)^2 = (14-y)\ (y-2) = 16y - y^2 - 28$$

and,

$$x = \sqrt{16y - y^2 - 28} \qquad (1)$$

Now, in the right-angled triangle OFG,

$$2^2 = (4-x)^2 + (y-2)^2, \text{ or } y^2 - 4y + 16 = 8x - x^2 \qquad (2)$$

Substituting the value of x from Equation (1) in Equation (2),

$$12y - 12 = 8\sqrt{16y - y^2 - 28}$$

Squaring both sides of this equation and arranging terms,

$$208y^2 - 1312y + 1936 = 0$$

By removing the factor 16, the following expression is obtained

$$13y^2 - 82y + 121 = 0$$

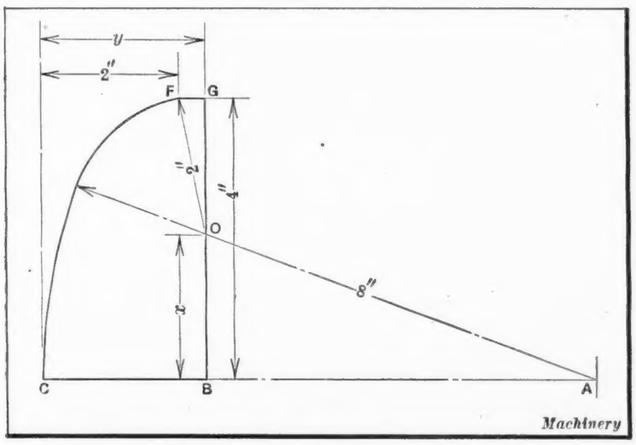


Diagram illustrating Conditions of Problem to find Center from which Arc is struck

Solving this quadratic equation,

$$y = \frac{41 \pm 6\sqrt{3}}{13}$$

By using this equation with the minus sign before the radical, it will be found that $y = 2.3544$ inches.

In developing Equation (1) it was shown that

$$x = \sqrt{(14-y)\ (y-2)}$$

Now, substituting the value found for y in this equation,

$$x = \sqrt{(14 - 2.3544)\ (2.3544 - 2)} = \sqrt{11.6456 \times 0.3544}$$

and

$$x = 2.0315 \text{ inches}$$

W. W. J.

CALCULATION FOR BLANKING DIE

D. C. A.—Fig. 1 shows a stamping to be produced on a punch press; from the dimensions given, please explain how to find radius x which is required in making the blanking die.

A.—At A in Fig. 2, letters are substituted for the known dimensions of the stamping involved in calculating radius x, and at B the conditions of the problem are illustrated diagrammatically. In both cases $R = 2$ inches, $r = 1$ inch, $b = \frac{1}{2}$ inch and $h = \frac{1}{8}$ inch. The two following relations are obtained from trigonometry:

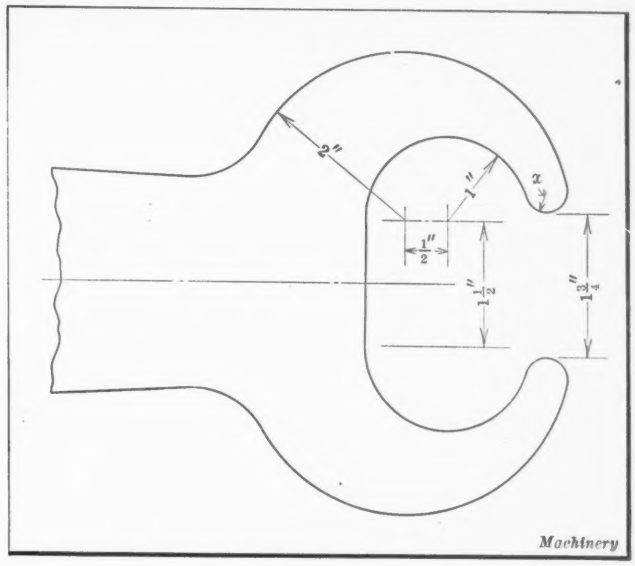


Fig. 1. Stamping for which Blanking Die is to be built, Radius x being unknown

$$(R - x)^2 = (y + b)^2 + (x + h)^2 \qquad (1)$$

$$(r + x)^2 = y^2 + (x + h)^2 \qquad (2)$$

Subtracting Equation (2) from Equation (1),

$$(R - x)^2 - (r + x)^2 = (y + b)^2 - y^2$$

Then

$$y = \frac{R^2 - r^2 - 2x\ (R + r) - b^2}{2b} \qquad (3)$$

Substituting the value of y obtained in Equation (3) in Equation (2),

$$(r + x)^2 = \left[\frac{R^2 - r^2 - 2x\ (R + r) - b^2}{2b}\right]^2 + (x + h)^2$$

Through expanding and combining, the following quadratic equation is secured:

$$4\ (R + r)^2\ x^2 - 4\ [(R^2 - r^2 - b^2)\ (R + r) + 2b^2\ (r - h)] \times x + (R^2 - r^2 - b^2)^2 - 4b^2\ (r - h)^2 = 0$$

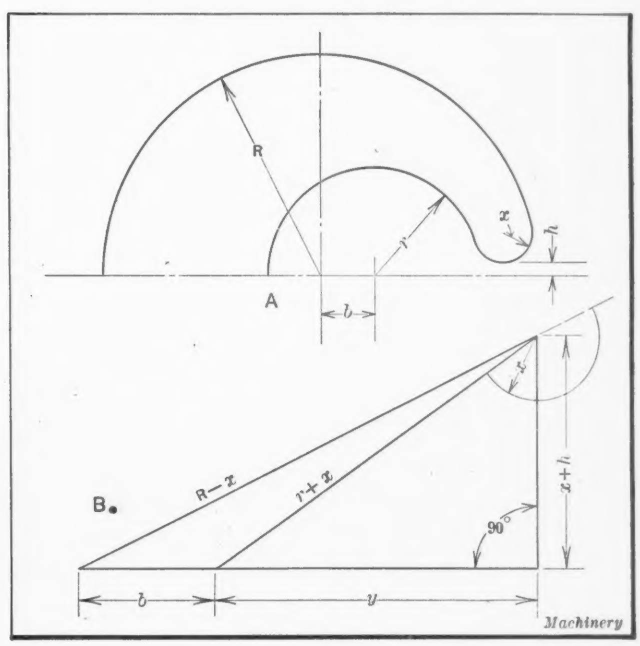


Fig. 2. Diagrams used in solving Diemaker's Problem

Solving this equation,

$$x = \frac{(R+r)^2 (R-r) - b^2 (R-r+2h)}{2 (R+r)^2} \pm \frac{2b\sqrt{(R+h)\ (r-h)\ (R+r+b)\ (R+r-b)}}{2 (R+r)^2}$$

In calculating radius x in Fig. 1 use this equation with the minus sign before the radical since b is positive and measures to the right of the point from which radius R is struck. Therefore,

$$x = \tfrac{1}{2} (R-r) - \frac{1}{2(R+r)^2} \times$$
$$[2b\sqrt{(R+h)\ (r-h)\ (R+r+b)\ (R+r-b)} + b^2 \times (R-r+2h)]$$

Substituting the numerical values given and then solving,

$$x = 0.2585 \text{ inch}$$

W. W. J.

FORMULA FOR FINDING FORMING TOOL ANGLE

H. R. B.—I wish to make forming tools for different sizes of poppet valve heads and would like a general formula for finding angle X from dimensions such as given in Fig. 1.

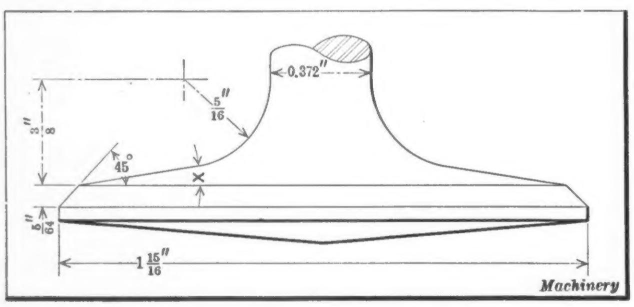


Fig. 1. Dimensions of Head of Poppet Valve

A.—By comparison with Fig. 1, the values for b, h, and r, Fig. 2, can be easily determined. Angle X can then be found in the following manner: Referring to Fig. 2,

$$\text{Tan } A = \frac{h}{b} \quad (1) \qquad c = \frac{h}{\sin A} \quad (2)$$

Also,

$$c = \frac{r}{\sin B} = \frac{r}{\sin (A-X)} \quad (3)$$

From Equations (2) and (3) by comparison,

$$\frac{r}{\sin (A-X)} = \frac{h}{\sin A}$$

$$\text{Sin } (A-X) = \frac{r \sin A}{h} \quad (4)$$

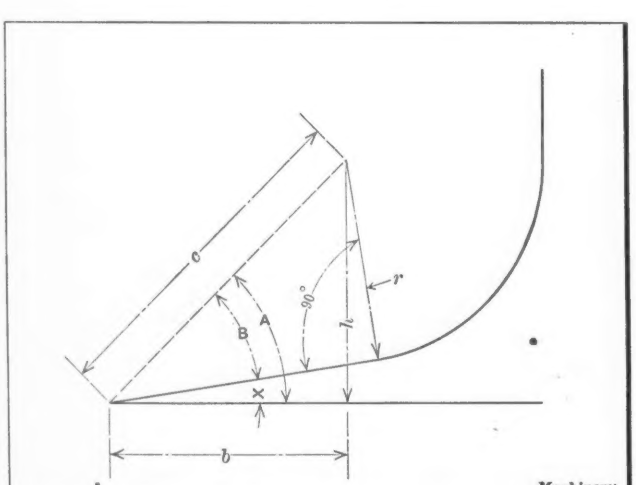


Fig. 2. Diagram used for solving for Angle X, Fig. 1

From the dimensions given in Fig. 1, it is obvious that $b = 0.392125$ inch, $h = 0.375$ inch, and $r = 0.3125$ inch. Substituting these values in Equations (1) and (4) and solving, angle A will be found to be 43 degrees 43 minutes 16 seconds, and angle $(A-X)$, to be 35 degrees, 10 minutes. By subtracting these two values, angle X will be found to equal 8 degrees 33 minutes 16 seconds. The easiest way of solving such problems is by the use of logarithms.

W. W. J.

DETERMINING THE LENGTHS OF TWO SIDES OF AN OBLIQUE TRIANGLE

H. W. P.—The accompanying illustration shows an oblique triangle in which the difference between the lengths of sides b and $c = 1$ inch; the length of side $a = 13$ inches; and angle $A = 120$ degrees. How can the lengths of sides b and c be found?

A.—According to the law of sines,

$$\frac{b}{a} = \frac{\sin B}{\sin A}, \text{ and } \frac{c}{a} = \frac{\sin C}{\sin A}$$

Therefore,

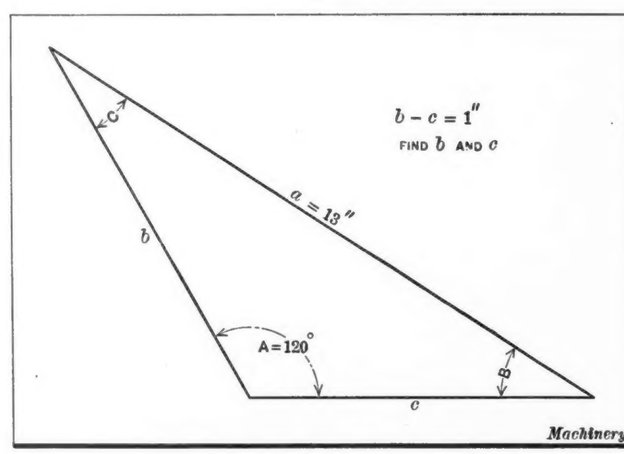
$$\frac{b-c}{a} = \frac{\sin B - \sin C}{\sin A} = \frac{2 \cos \frac{1}{2} (B+C) \sin \frac{1}{2} (B-C)}{2 \sin \frac{1}{2} A \cos \frac{1}{2} A}$$

But, since $\frac{1}{2}$ $(B+C)$ is the complement of $\frac{1}{2}$ A,

$$\text{Cos } \tfrac{1}{2} (B+C) = \sin \tfrac{1}{2} A$$

and

$$\frac{b-c}{a} = \frac{\sin \frac{1}{2} (B-C)}{\cos \frac{1}{2} A}.$$



Oblique Triangle in which the Difference between Sides b and c, and Angle A are known

From this equation,

$$\text{Sin } \tfrac{1}{2} (B-C) = \frac{(b-c) \cos \frac{1}{2} A}{a} = \frac{1 \times 0.5}{13} = \frac{1}{26}$$

By the law of tangents,

$$b + c : b - c = \tan \tfrac{1}{2} (B+C) : \tan \tfrac{1}{2} (B-C)$$

As $A + B + C = 180$ degrees, and $B + C = 180$ degrees $-$ A, then $\frac{1}{2}$ $(B+C) = 90$ degrees $- \frac{1}{2}$ A. Thus, tan $\frac{1}{2}$ $(B+C) = \cot \frac{1}{2} A$. Since $\sin \frac{1}{2} (B-C) = \frac{1}{26}$, then, by the following relation, $\tan \phi = \frac{\sin \phi}{\sqrt{1 - \sin^2 \phi}}$, it will be found that $\tan \frac{1}{2} (B-C) = \frac{1}{15\sqrt{3}}$.

Therefore,

$$b + c = \frac{(b-c) \cot \frac{1}{2} A}{\tan \frac{1}{2} (B-C)} = \frac{\frac{\sqrt{3}}{3}}{\frac{1}{15\sqrt{3}}} = 15 \text{ inches}$$

Now, if $b + c = 15$ inches and $b - c = 1$ inch, $b = 8$ inches and $c = 7$ inches.

W. W. J.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Newark No. 5 Gear-hobbing Machine

The Newark Gear Cutting Machine Co., Newark, N. J., has added a new No. 5 automatic hobbing machine to its line of gear-cutting machinery. This machine is a special simplified type, designed primarily for the rapid production of helical and herringbone gears for use on street railway cars, electric locomotives, mill drives, and numerous other applications in the industrial field. Of course, the same machine can also be employed for hobbing worm-wheels and spur gears.

A noteworthy feature of the machine is its ability to hob helical gears of comparatively small helix angles just as readily as gears having relatively large helix angles. Fig. 1 shows the machine cutting a cast-iron helical gear of 1¾ normal diametral pitch, and having such a small helix angle (7 degrees relative to the axis) that it bears a rather close resemblance to a spur gear. Heretofore it has been a simple matter to hob helical gears having angles ranging from 15 to about 45 degrees, but it has been difficult on most designs of hobbing machines to cut helical gears of such large leads that the teeth appear to be almost parallel with the axis. With this No. 5 machine the mechanical and mathematical difficulties have been overcome, so that helical gears with angles of only 3, 4, or 5 degrees with the axis may be hobbed as well as gears with large helix angles.

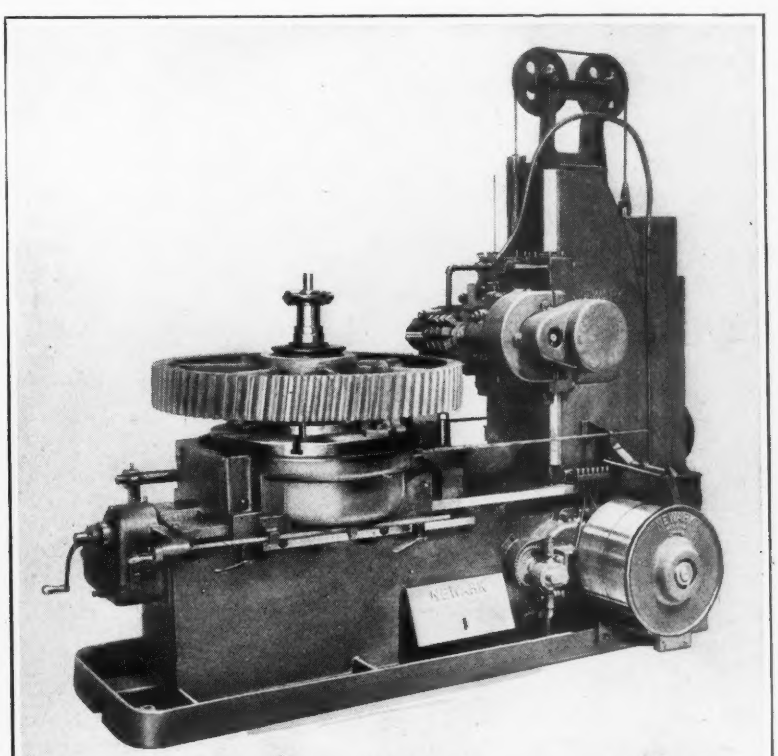


Fig. 1. Newark No. 5 Gear-hobbing Machine cutting a Cast-iron Helical Gear

In order to obtain a true bearing between helical gears designed to run on parallel shafts this machine employs an improved method of helical control through the use of differential gearing placed in the ratio or dividing train of gears ahead of the indexing change-gears. Thus the modification of the motion for the "one-tooth lead" in the ratio train is multiplied in absolute proportion to the number of teeth desired in the finished gears. The term "one

tooth lead" is literally the lead distance from one tooth to another measured along the axis. Mathematically, it is the full helix lead divided by the number of teeth. The machine, therefore, does its own multiplying for all numbers of teeth, and obtains the full helix lead in absolutely correct proportion for all ratios, regardless of any possible slight error in the lead gears. For example, a gear of 100 teeth, having a 100-inch full helix lead has a "one tooth lead" of 1 inch. The machine then automatically multiplies this lead to 100 inches for 100 teeth, or to 79 inches for 79 teeth, etc.

If three gears having, say, 18, 37, and 16 teeth, respectively, are to be cut to run together on parallel shafts, the machine is geared up for the "one tooth lead" of this train, and this lead gearing remains constant during the cutting of the whole train, thereby automatically producing the same angle and consequently a true bearing along the teeth of all the gears in the train. A chart is furnished with this machine which gives the "one tooth lead" change-gearing for most of the commonly used angles and normal diametral pitches. The angles are given to each 5 minutes of arc. With this chart, the choosing of lead gears is just as simple as choosing the indexing gears, and no calculation is required on the part of the operator. The "one tooth leads" can also be obtained by the following formulas, the proper one depending on the pitch used for sizing the helical gear. (The helix angles in these formulas are from the axis of the gear).

For helical gears calculated to normal diametral pitch,

$$\text{"One tooth lead"} = \frac{3.1416 \times \text{cosecant of helix angle}}{\text{Normal diametral pitch}}$$

For normal circular pitch,

"One tooth lead" = Normal circular pitch × cosecant of helix angle

For diametral pitch (not normal),

$$\text{"One tooth lead"} = \frac{3.1416 \times \text{cotangent of helix angle}}{\text{Diametral pitch}}$$

For circular pitch (not normal),

"One tooth lead" = Circular pitch × cotangent of helix angle

A chart is also furnished in which the "one tooth lead" change-gearing is arranged numerically. This enables gearing to be readily chosen to duplicate or match gears cut on older types of machines. Excellent bearing surfaces between gears cut on this machine and those cut on metric machines have been obtained.

Fig. 3 shows how the helical control mechanism and the

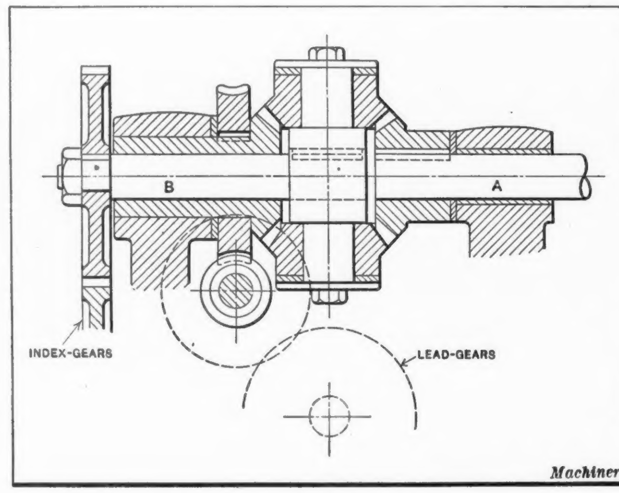


Fig. 3. Arrangement of Gearing on No. 5 Gear-hobbing Machine

indexing or ratio mechanism are combined by means of differential gearing. The driving shaft A revolves at twice the speed of the driven shaft B upon which the index gear is placed, thus increasing the power and smoothness of action of the indexing worm train. The machine, when belt driven, receives power through constant-speed tight and loose pulleys mounted on the machine, no countershaft being required. A flywheel is mounted on the cutter-spindle pinion-shaft, instead of on the cutter-spindle. This permits a light flywheel at the right place to be more efficient than a heavy one in the wrong place.

Ten changes of cutter speed are provided. Feed motion is controlled by one lever, which connects with the indexing train for feeds governed by the revolutions of the work, or with the constant-speed driving train for feeds per minute. The latter feeds are used with ordinary disk cutters for cutting helical gears for which no hob may be available. This is a semi-automatic operation, the indexing being done by hand with a special attachment. Fifty-five changes of feed are provided. The feed can be changed at any time, no extra calculation being required. If, after beginning to cut a blank, the material is found to be softer or harder than estimated at the start, an increased or decreased feed can be obtained without refiguring the lead gears.

The cutter carriage has a quick-return motion whereby hobs can be returned to the top of the gear blank for a second or finishing cut, if found desirable, and again passed through the cut without any special resetting of hair lines or zero marks; that is, the machine automatically holds the hob in the work, in the proper helical path. The clutch lever controlling the vertical feed-screw is locked in the operative position when set for cutting helical gears, so that accidental disconnecting of the helical train of motion by the operator is avoided. The work-table is arranged to take solid pinions, where the teeth are cut integral with a shaft. Such pinion-shaft shanks up to 10 inches diameter can be accommodated. Regular taper-shank work-arbors are held in a rigid flange bearing or adapter in the work-table.

For the rapid cutting of pinions and wide-face gears up to 28 inches in diameter, a massive outside support bearing is provided for the outer end of the work-arbor as shown in Fig. 2. This support is of box section, and has an arm mounted on it that grips the work-arbor through an adjustable sleeve. The unique feature of this support consists in the ease with which gear blanks can be mounted or re-

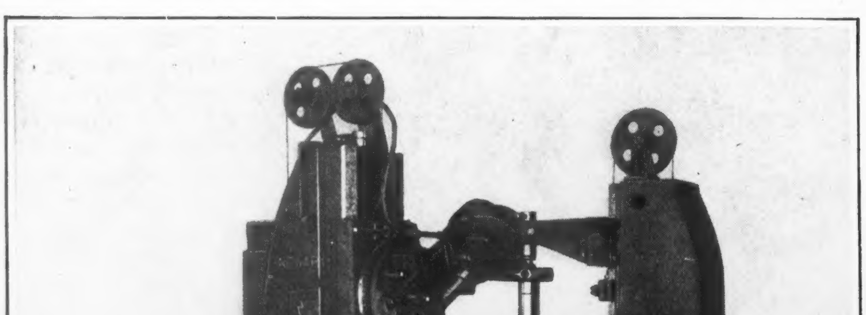


Fig. 2. No. 5 Gear-hobbing Machine equipped with Rigid Support for Work-arbor

moved without disturbing any of the vertical adjustments of the support as set for the job at hand. The support arm is simply unclamped and swung to one side where it is out of the way. After mounting a new blank, the arm is swung back in place and again tightened. Larger gears up to 60 inches diameter are supported by height blocks and jacks.

The machine is provided with automatic trips to the vertical cutter movement and the horizontal work movement. The vertical trip always operates to stop the entire machine. The machine is rated for cutting 2½ diametral pitch in steel or 2 diametral pitch in cast iron at a rapid production rate, and with a minimum grinding of hobs.

Additional specifications are as follows: Face capacity, 18 inches; minimum centers between work- and cutter-arbors, 2½ inches; hob capacity, 7¾ inches diameter by 9 inches long; diameters of cutter-arbors, 1¼ and 1½ inches; work-arbor diameter, 2¼ inches; motor drive, when furnished, requires constant-speed 7½- to 10-horsepower motor with a speed of 1100 to 1200 revolutions per minute. The machine weighs 14,000 pounds.

HEIM CENTERLESS ROLL GRINDER

A grinding machine for automatically grinding cylindrical work without placing such work on centers, is now being manufactured by the Ball & Roller Bearing Co., Crosby St. and Maple Ave., Danbury, Conn. This machine is known as the Heim centerless cylindrical roll grinder, and is the invention of L. R. Heim, general manager of the company. The machine is adapted for grinding work such as rolls for roller bearings, wrist-pins, camshafts, valve lifters, valve-lifter roll-pins, pistons, shackle bolts, spring bolts, roller chain studs, or in fact any cylindrical part that requires grinding on only one diameter. A large battery of these grinders is in use in the Ball & Roller Bearing Co.'s plant in connection with the manufacture of journal roller bearings, radial roller bearings, and various small cylindrical parts manufactured for the trade by this company.

General Features of Construction

Figs. 1 and 2 show front views of the latest design of this machine. In Fig. 1 the machine is shown with the doors or covers removed from the wheel housing so that the position of the regulating wheel and the grinding wheel may be seen. This illustration also shows the roll-supporting fixture, and the chute in which the rolls are placed and from which they pass into the roll support, and thence between the grinding and regulating wheels. It will be noticed that there is a platform or shelf at the front of the machine on which the rolls or supply of work can be placed in a convenient position for the operator. In feeding, the operator places the pieces to be ground in the chute, which is supported by a rod clamped to the shelf, as shown. Underneath the work-holding shelf is a water tank provided with a tray into which the work is automatically dropped after being ground. The tray into which the work falls is hung from the top of the water tank, and can be easily removed and dumped when it is full.

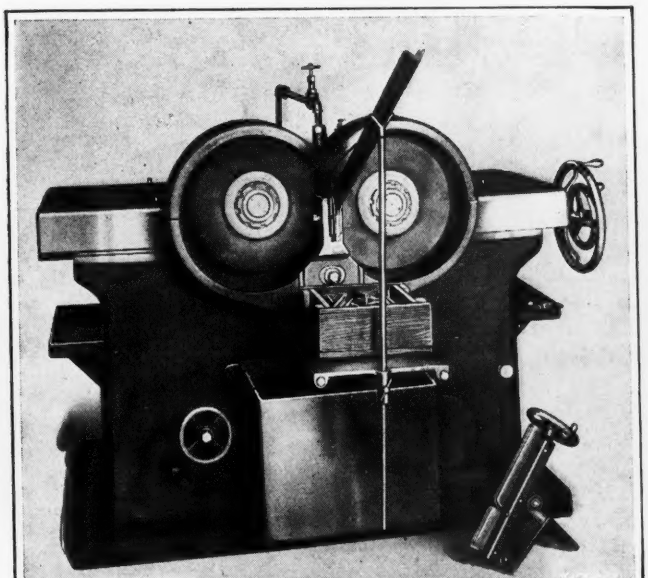


Fig. 1. Heim Centerless Roll Grinder with Wheel Housing Cover removed

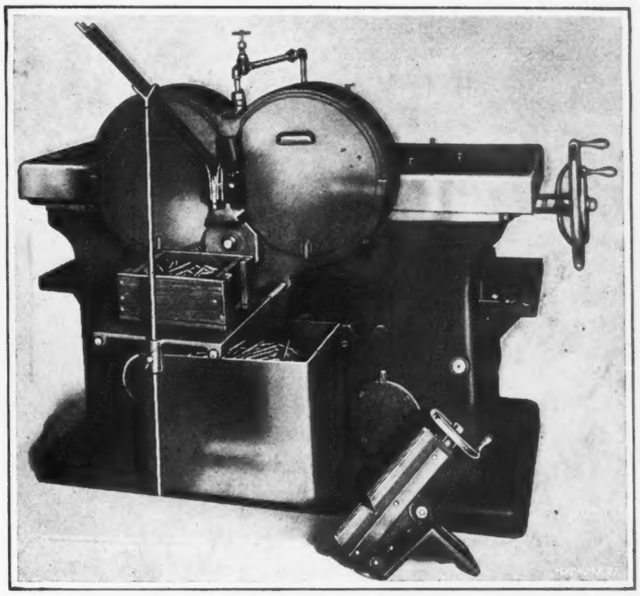


Fig. 2. Heim Centerless Roll Grinder made by Ball & Roller Bearing Co.

The roll-regulating wheel and the grinding wheel are adjusted in respect to each other and the roll-supporting fixture, by means of the two handwheels shown at the right-hand end of the machine. The grinding wheel and regulating wheel are each mounted on a slide, which, in turn, is mounted on the top of the main bed of the machine. These slides, the housings for the wheels, and the regulating spindles are of heavy construction, as will be readily apparent by referring to Fig. 3. On each side of the machine base, there is a large opening. The openings at the ends of the base and the one at the rear are provided with metal doors. Over the doors of the openings at the ends of the machine are hung trays for holding tools. The opening at the rear of the machine gives easy access to the mechanism inside the frame.

The water tank, fastened to the front of the bed, serves as a cover for the front opening in the base. Attached to the water tank is a centrifugal pump, driven from the main drive shaft of the machine. This pump supplies the grinding and regulating wheels with a constant flow of coolant.

Design of Driving Mechanism

The drive shaft for driving the grinding spindle and also for conveying power to the regulating wheel spindle and coolant pump is hung in the main bed of the machine, and is mounted on radial roller bearings, which are enclosed in a substantial housing and rotate in oil. From this drive shaft, power is conveyed to another shaft on which is mounted a speed reduction gear. This gearing and the shaft to which it is attached are enclosed in a housing and run in oil. By the use of this gearing, four speeds can be transmitted to the regulating wheel spindle. The design of the machine is such that the driving belts of the regulating wheel spindle and the grinding wheel spindle pull from underneath, and therefore have a tendency to hold the wheel-slides down in contact with the bed of the machine, thus adding to the rigidity of the slides in which the wheel-spindles are mounted. The slack in these driving belts is taken up by idlers mounted on anti-friction bearings.

The wheel-spindles are made from a special alloy steel, hardened, tempered, and ground, and they run in large phosphor-bronze bearings. These bearings provide automatic

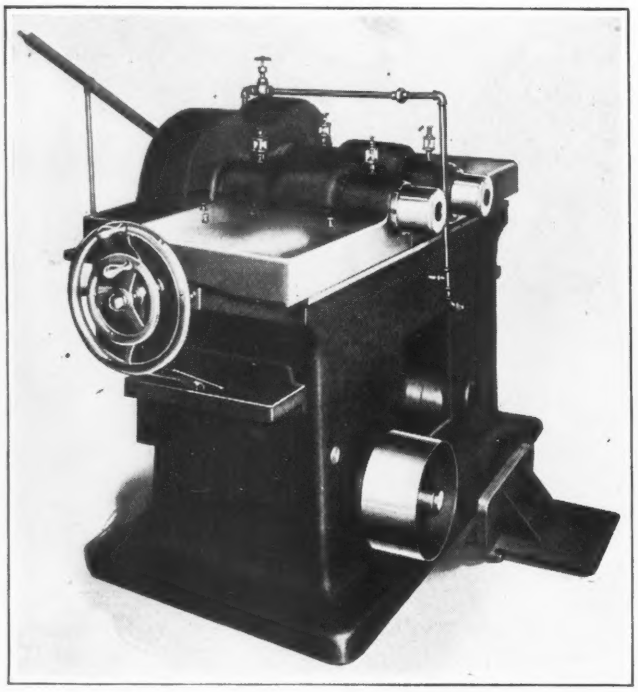


Fig. 3. Rear View of Heim Centerless Grinder

lubrication for the spindles, and the design is such that grit and dirt are absolutely excluded. The lateral thrust on the spindles is taken by ball bearings.

Operation of Machine

One operator can take care of a machine; that is, under normal conditions, he can keep the chute full of work and attend to the gaging and adjusting of the wheels. In some instances, it would be possible for one operator to attend to more than one machine, depending upon the nature of the work to be ground. When very long runs of any one size of work are to be ground, automatic feeders can be provided, so that one operator can run several machines, it merely being necessary for him to adjust the wheels, gage the work, and fill the magazines at regular intervals. The machine can be provided with tight and loose pulleys to be driven from a countershaft, or it can be driven by a motor either hung to the ceiling, set on the floor, or mounted on the machine at the end of the bed.

A diamond wheel-dresser shown in the lower right-hand corner of Figs. 1 and 2 is furnished with the machine. This device is placed between the two wheels and fastened to the machine, after first removing the roll-supporting fixture. The truing diamonds are passed back and forth across the faces of the wheels by operating the handwheel at the end of the truing fixture. In this way the faces of both wheels are dressed parallel with each other.

The changing of the speed of the regulating wheel is accomplished by the use of a handwheel shown on the left side of the main bed of the machine near the coolant tank. By turning this handwheel in one direction, the speed of the regulating wheel can be changed from that employed for grinding to that employed for dressing the wheel. By a slight turn of this wheel, the power drive can be disconnected from the regulating wheel.

It is claimed by the manufacturers that exceptionally high production rates can be obtained by the use of this machine, the increase in some instances ranging as high as from 100 to 500 per cent over the ordinary method of grinding, and at the same time a high degree of accuracy can be maintained. The grinding and regulating wheels employed on this machine are of the regular type such as are used on external grinders, and the life of the grinding wheel is approximately the same as that of an external grinding wheel, while the life of the regulating wheel is much greater. This machine occupies a floor space of 4 by 6 feet, and when equipped for belt drive it weighs approximately 4500 pounds.

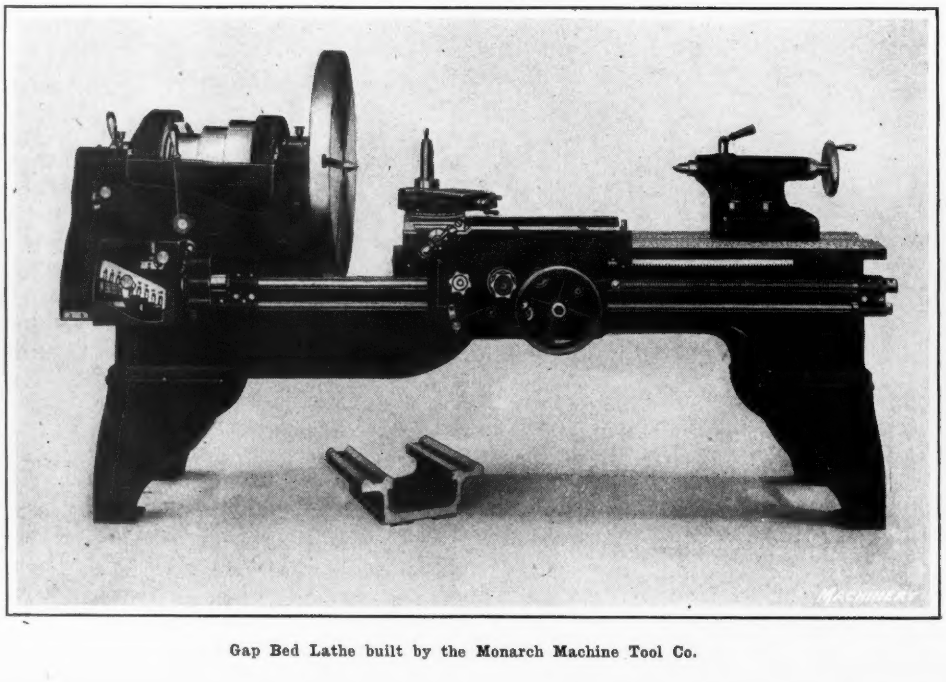
MONARCH GAP BED LATHE

The gap bed lathe shown in the accompanying illustration is one of five sizes now being manufactured by the Monarch Machine Tool Co., 109 Oak St., Sidney, Ohio. The carriage is of unusually heavy construction, and the rear carriage wings are extended at the tailstock end in order to form a long bearing that will withstand heavy service. The carriage is gibbed, both at the front and the rear, and the cross-bridge and power cross-feed slide are extended to permit taking facing cuts the full swing of the gap without undue stress or chatter. The carriage is also built so that it will overhang the gap, thus permitting the tool to be used close to the faceplate, if necessary.

The gears contained in the apron are of drop-forged steel. The apron is double-walled, permitting bearings at both ends for the studs and shafts. It is provided with a feed reverse, and interlocking device which prevents the feed-rod and lead-screw from being engaged at the same time. The rack and pinion disengages when screw-cutting.

The headstock is of the solid bowl-shaped box housing construction. The quick-change gear-box is of simple design, and the thread and feed range is sufficient to cover all ordinary requirements. The change-gears are made of steel, and are of coarse pitch; they are wide-faced, bushed with bronze, and run on vanadium-steel shafts. The spindle is made of 50-point carbon crucible steel; it is accurately ground and runs in a phosphor-bronze bearing.

The back-gears are locked in and out of position by a spring plunger. The double back-gears are of the positive geared type. The compound rest is gibbed throughout, and has liberal bearing surfaces. The usual swivel and cross-feed graduations are provided. Drilled and tapped holes are provided on the back of the carriage for receiving a taper



Gap Bed Lathe built by the Monarch Machine Tool Co.

attachment which can be furnished when desired. The five sizes in which this machine is regularly made are as follows: 14–23 inches by 6 feet; 16–25 inches by 6 feet; 16–27 inches by 8 feet; 18–28 inches by 8 feet; 20–30 inches by 8 feet. The lathe can also be furnished with beds of greater lengths.

FRONTIER AIR-OPERATED CHUCKS

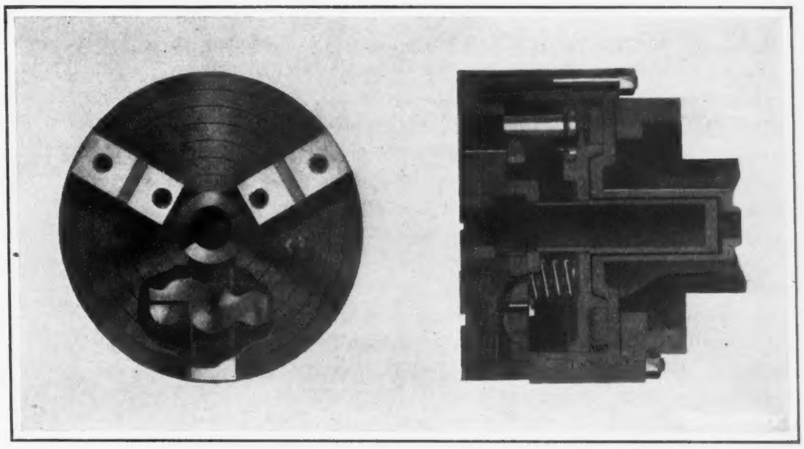


Fig. 1. "Lavoie" Air-operated Pilot-bar Chuck made by the Frontier Chuck & Tool Co., Inc.

Two new designs of air-operated chucks sold under the trade name of "Lavoie" have been produced by the Frontier Chuck & Tool Co., Inc., 30 Letchworth St., Buffalo, N. Y. One of these chucks—a pilot-bar type—which was especially developed for work that requires piloted tools is illustrated in Fig. 1. By reference to this illustration, it will be seen that the air cylinder and the chuck are one complete unit and that the air source is at the back of the outer tube, the air being piped through the spindle of the machines on which the chuck is mounted. A revolving air box at the rear end of the spindle makes connection to the air valve. A tube is screwed into the piston which allows a pilot-bar of any desired length to enter without interfering with any other part of the chuck. This tube also prevents dust and chips from entering the mechanism of the chuck.

The chuck-operating mechanism consists of wedge spindles of the circular type having flat inclined surfaces. Each spindle rests against one end of a lever and is held in place but is free to revolve on the face of the piston. The wedges, one for each jaw, rest against a similarly tapered surface on the end of the lever that is pivoted at the opposite end and pinned to a jaw at the center. Thus when the air is admitted to the cylinder, the piston and the wedge spindles are forced forward, causing the levers to swivel on their fulcrums and bringing the jaws toward the center of the chuck. When the air is turned off, springs force the piston and jaws back to their original positions. It will be noted that the pilot-bar is guided by the pilot bushing which is screwed into the face of this chuck and that the outer pilot tube has no movement whatsoever.

The second chuck, which was developed for application on drilling machines, is illustrated in Fig. 2. This chuck is provided with holes so that it can be bolted to the machine table. Its operation is similar to the chuck previously described, but in this case the air is admitted at one side instead of the back. As the opening runs clear through the center, danger of chips working into the center is eliminated. The base is raised on four legs about 1 inch high, which allows the operator to rake out any chips that might accumulate by falling through the opening in the center. Both chucks are made with either two or three jaws, and in manufacturing or adjustable types, and the sizes are 10, 12, 15, and 18 inches.

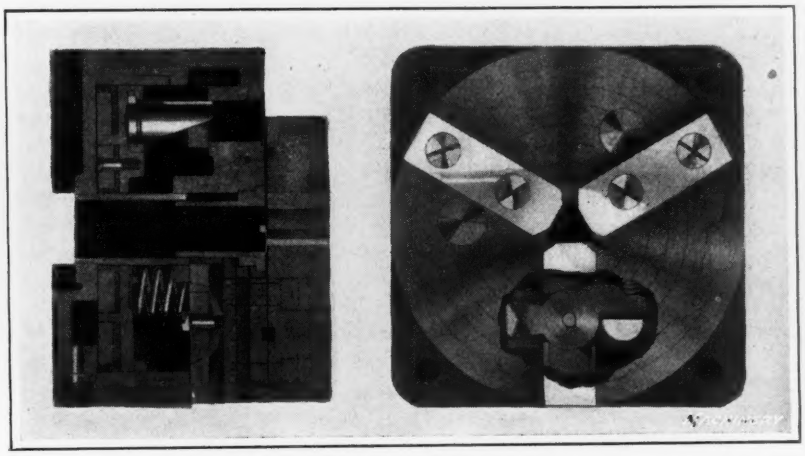


Fig. 2. Design of Pneumatic Chuck for Application on Drilling Machines

GEIRAS INDEXING HEAD

An indexing head known as "Lightning," which differs considerably in design from styles made by other concerns has been developed by the Geiras Mfg. Co., Inc., 417-419 E. 156th St., New York City, for application in small shops or on machines engaged continuously on a class of work requiring the use of such an appliance. The outstanding feature of this head is that after certain adjustments have been made, prior to taking the first cut on a piece of work, the latter can be rapidly indexed for each successive cut by simply operating a handle back and forth; it is unnecessary to give further attention to the setting of the indexing mechanism because accurate indexing is assured through an automatic arrangement. Reference to the accompanying illustrations will show that the index-plate *A* is provided with teeth around its periphery and that a plunger *B* is held in a housing attached to the base. The positive indexing of work is obtained by causing this plunger to spring into engagement with the teeth of the index-plate when the work has been revolved the required amount.

Setting the Indexing Mechanism

In setting the head to suit the specifications of any job, the two locking screws *C* are first loosened. These screws furnish means of securing plates *D* and *E* together after a setting has been made, so that the relation between stop *F* on plate *D* and trip *G* on plate *E* will remain the same until the setting is altered. After screws *C* have been loosened, the index-plate is revolved until a certain tooth space, above which a line is scribed, is placed directly above the plunger. Plate *E* is then rotated until trip *G* comes in contact with trigger *H*, which is also mounted in the plunger housing and keeps the plunger depressed. However, as trip *G* strikes trigger *H*, the plunger is released and is forced into the tooth space by means of a coil spring placed beneath the plunger, thus preventing further movement of the index-plate.

The next step is to locate the tooth space diametrically opposite the one above which the scribed line is placed, and then, in a clockwise direction, count the number of tooth spaces which, when divided into the total number of teeth on the index-plate, will give a result equal to the number of divisions desired on the work. For instance, if the index-plate has sixty teeth and it is desired to index the work in order to mill four equally spaced slots, fifteen tooth spaces should be counted.

The plate D is then swiveled until the screw I, which is held in a bracket attached to plate D, is placed directly above the last space counted. Screw I is then turned, forcing a tapered pin into the tooth space above which it is placed, and locking the index-plate and plate D together. It will be seen that in this way the distance between stop F and trip G is regulated to suit the conditions of the job. Screws C are next retightened, after which the pin operated by screw I is withdrawn from engagement with the teeth, and after the index-pin contained in handle J has been placed in any one of the holes of the index-plate, the head is ready for the work. Handle J is keyed to the hollow spindle of the head, thus causing the spindle to rotate with the index-plate. The use of the pin operated by screw I eliminates the danger of inaccurate settings which would occur if plate D should move slightly in relation to the index-plate while screws C are being tightened.

Procedure Followed in Indexing Work

In operation, when viewing the head from the index end, the work is indexed by simply pushing handle L toward the right, plates D and E and the index-plate moving as one unit after plunger B has been withdrawn from engagement with the teeth of the index-plate by means of a second trigger K on plate D. The three plates are then rotated until trip G strikes trigger H, permitting plunger B to be forced into the proper tooth space on the index-plate and preventing further rotation of the parts in that direction. The handle is then pushed toward the left until stop F strikes the plunger housing, only plates D and E being returned, as the index-plate is held stationary by the plunger.

The movement of the plates independently of the index-plate is made possible by a ratchet mechanism that is engaged when the handle is pushed toward the right but disengaged when pushed toward the left. The various parts are thus placed in position for again depressing the plunger and revolving the index-plate and work after an operation has been performed on the work. An important feature of this arrangement is that even though handle L may be turned only part way toward the right and then returned to its original position before the plunger is operated, the relation between the moving members will remain the same and the setting will not be altered.

The various sets of holes in the index-plate are used for indexing in connection with the teeth when the desired number of divisions on the work cannot be obtained with the teeth alone. For instance, suppose it is required to cut one hundred slots around a piece, and there are only sixty teeth on the plate. In this case, the plunger is made to spring into every third tooth space when handle L is operated as previously described, so that twenty equally spaced slots can be milled on the work. During this step, the index-pin in handle J is put in the hole farthest to the left in row M, as shown in Fig. 2. After twenty slots have been milled, this pin is advanced to the second of these holes, the result being that the relation between the spindle and the index-plate has been changed such an amount that twenty more slots can be milled around the work, each slot being the desired distance from those machined the first time. By placing the pin successively in each of the holes in row M and indexing completely each time, one hundred equal divisions can be obtained. Handle J is adjustable in its bearing to suit the various sets of holes in the plate.

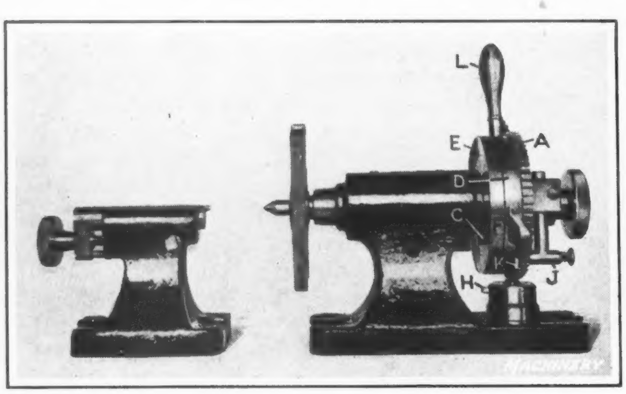


Fig. 1. New Type of Indexing Head and Footstock made by the Geiras Mfg. Co., Inc.

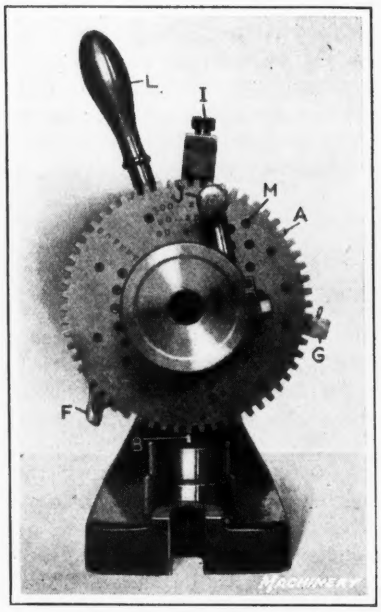


Fig. 2. Indexing End of Head

Equipment Furnished with Indexing Head

Nine index-plates are made for permitting any number of divisions up to 100, except the prime numbers above 40 and, in addition, special plates can be supplied to suit the needs of a customer. The head is provided with a driving plate of standard design for holding work between centers, and there is a draw-bar extending through the hollow spindle for the operation of draw-in collets having a capacity for holding work up to 9/16 inch in diameter. When a chuck is mounted on the front end of the spindle, work up to 13/16 inch in diameter may be passed through the spindle.

The footstock furnished with the indexing head is also shown in Fig. 1. A pin located at the rear and about 2 inches below the point of the center insures that the latter will always be central within a very small error. The center is adjustable axially by means of a knurled-head screw at the rear of the footstock, and is clamped at the front. A cam-operated footstock can also be furnished when an exceptionally quick-operating center is desired. The various steel parts on the head and footstock are hardened and ground, while some of the more important are lapped. This equipment has been employed for several years in the manufacture of milling cutters, and its use has given such satisfactory results that it was decided to place it on the market.

HEALD CYLINDER GRINDING MACHINE

The Heald Style No. 55 cylinder grinding machine shown in the accompanying illustrations has been brought out by the Heald Machine Co., 16 New Bond St., Worcester, Mass., in response to the demand for a machine of simple, substantial design, adapted for regrinding automobile cylinders and general repair work. This machine is designed along the same general lines as the No. 60 cylindrical grinding machine of this company's manufacture, and will handle a large variety of cylinders, as well as a miscellaneous class of awkward shaped castings that cannot be revolved while performing the grinding operation. The expensive speed-change boxes and other units incorporated in the design of the No. 60 machine, which are so necessary in a manufacturing machine of that type have been eliminated from the No. 55 machine, the speed-change box being replaced with a drive from a single shaft at the back of the machine. The new machine is also self-contained; that is, no countershaft is required, it being only necessary to belt from the main lineshaft to the rear drive shaft. While these changes enable the No. 55 machine to be sold at a lower price than the No. 60, the No. 55 machine will nevertheless handle all cylinder grinding, and the general class of work met with in jobbing shops.

In addition to simplifying the machine as described, other changes have been made which better adapt the machine for the particular purposes for which it is designed. These

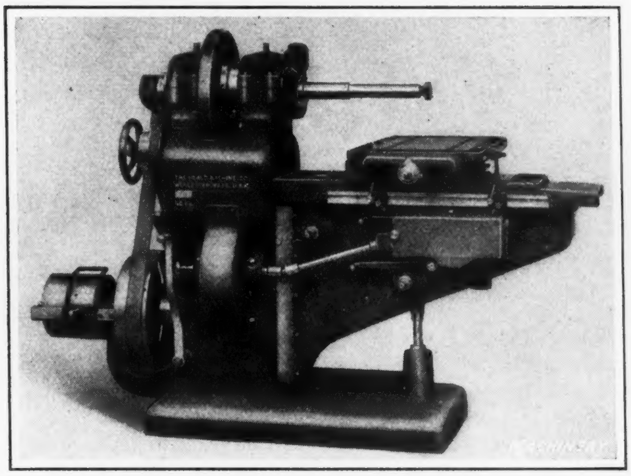


Fig. 1. Front View of No. 55 Cylinder Grinding Machine built by the Heald Machine Co.

changes include an increase in the width of the knee and main table, so that when grinding large work, such as six-cylinder castings of the en bloc type, there is no undue overhang on either side when grinding the holes at the extreme ends of the casting. The distance between the center line of the grinding spindle and the top of the cross-slide table has also been increased over that of the No. 60 machine. On the No. 60 machine, this distance ranges from 4¼ to 7½ inches, and in the new style No. 55 machine from 7 inches minimum to 9½ inches maximum. This is of considerable importance where a great variety of work is done, and will be especially appreciated in jobbing shops where large castings are frequently ground.

The main casting is a column on the top of which is a grinding spindle carried in a cylindrical rotating head or sleeve. This rotating head is made up of two eccentrics, one inside the other, giving the grinding spindle a sort of planetary adjustment for accurately feeding the wheel to the work. It has two speeds, being driven by a belt from a two-step cone on the main drive bracket. On the front of the column, and having an extra long bearing, is mounted the massive knee. This knee has a vertical adjustment of 2½ inches, and carries the main sliding table which travels forward and back in a line parallel to the grinding spindle.

The main table is made heavy with ample wearing surfaces and of sufficient length to fully protect the ways on which it slides from grit and dust. Oil-pockets with rolls provide continuous lubrication. The travel of the main table is automatic, reversing automatically at any desired point. Two speeds are instantly obtained by a simple movement of a knob on the front of the machine. A cross-slide table mounted on the main table gives crosswise adjustment to the work. The feed-screw of this cross-slide is graduated to read to thousandths of an inch. Adjustable dogs are provided to facilitate setting the table in different positions, as required when grinding the bores of en bloc cylinder castings. The exact distance between the centers of the cylinders can be obtained by means of a micrometer dial attached to the cross-feed screw; the dial is set at zero from the first hole, and the position of the dial noted for the other holes.

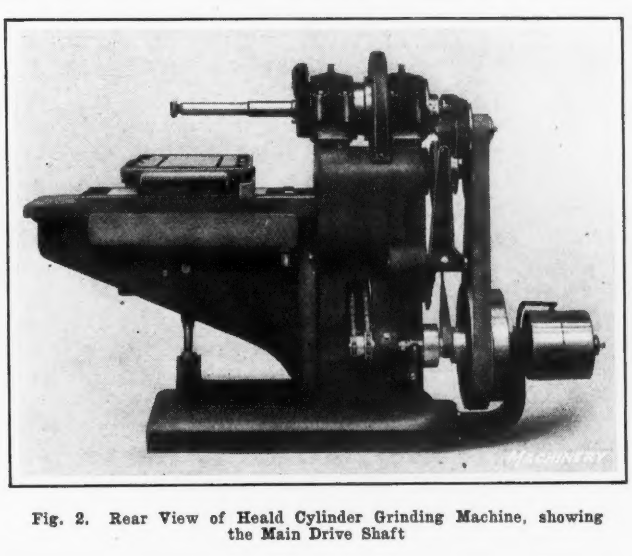
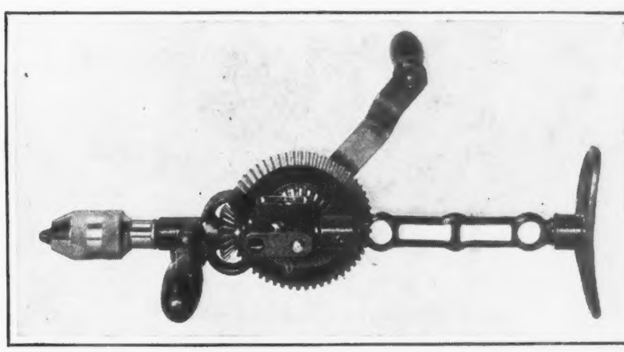


Fig. 2. Rear View of Heald Cylinder Grinding Machine, showing the Main Drive Shaft

The wheel-spindle is hardened, ground, and runs in a solid taper bronze bearing at the wheel end, with a self-aligning ball bearing at the pulley end. It is fitted with interchangeable pulleys to give different speeds to the grinding wheels, so the operator always obtains exactly the right speed, whether using large or small wheels for the work in hand. The depth of cut is obtained by the feed mechanism on the right-hand end of the rotating head, which is operated either by a knob when small adjustment is desired, or by a small crank on the shaft below when large adjustments are to be made, as in going from one size of hole to another.

Interchangeable wheel-spindle and arm units can be furnished, which give the machine a range for grinding holes from 1⅛ inches in diameter by 7½ inches long up to 5 inches in diameter by 16½ inches long. The wheel-spindle regularly furnished with the machine grinds holes 2⅜ inches in diameter and larger, by 11 inches long; also holes 3 inches in diameter and larger, by 18 inches long. The standard grinding wheels for the regular 11- and 18-inch spindles are 2½ and 3½ inches in diameter, and their speed is 4950 to 5650 surface feet per minute. The machine occupies a floor space of 72 by 110 inches, is equipped with tight and loose pulleys, 10 inches in diameter by 4½ inches face width, which should be driven at 700 revolutions per minute. A 5-horsepower motor, running at 1000 to 1200 revolutions per minute, is recommended. The net weight of the machine is approximately 2900 pounds.



Breast Drill with Three-jaw Chuck made by the Consolidated Tool Works, Inc.

CONSOLIDATED BREAST DRILL WITH THREE-JAW CHUCK

The Consolidated Tool Works, Inc., 261 Broadway, New York City, manufacture the breast drill shown in the accompanying illustration which is equipped with a three-jaw chuck that is without springs or other devices liable to get out of working order. The breast-plate is adjustable to various angular positions, and the speed change is controlled by a push-pin. The over-all length is 18 inches. The drill may be furnished with a level attachment if desired.

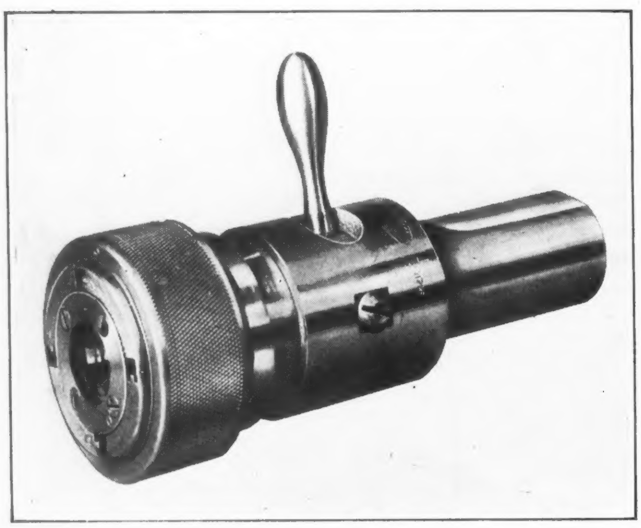
VICTOR SELF-OPENING DIE-HEAD

The new Style E Victor self-opening die-head shown in the accompanying illustration, which has recently been brought out by the Victor Tool Co., Waynesboro, Pa., is a development of the Style D self-opening die-head of this company's manufacture. The new die-head has been considerably simplified in its construction, and is said to be even more positive in its operation than the previous style. Instead of using separate plungers for holding and actuating the chas-

ers as in the Style D die-head a ring is now used for this purpose which controls and actuates the chasers by means of slots and tongues which fit corresponding slots and tongues in the chasers. The same style chasers with tapered edges used in Victor collapsible taps have been employed in the new die.

The accompanying illustration shows the die closed in the cutting position. It will be noted that when in this position the chasers are fully supported for their entire length back of the cutting point, thus preventing any possibility of tipping or tilting which would result in cutting a tapered thread. The size adjustment for cutting tight or loose threads is obtained by simply turning a large knurled collar, which is accurately graduated. A range of approximately 1/16 inch either over or under size can be obtained by adjusting this collar. A small locking screw is provided for holding the adjusting collar securely in place when the desired set has been made.

For cutting threads close to a shoulder, provision is made for extending the chasers through the cap. Standard shanks are made hollow to permit the threading of long rods. Special shanks can be made, however, to meet the requirements of a customer. The heads are made either in the regular pull-off type, which automatically opens when the travel of the carriage head is stopped, or they can be furnished with



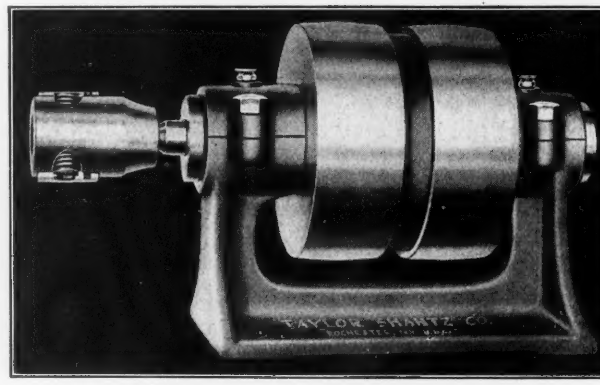
Self-opening Die-head made by the Victor Tool Co.

an internal tripping device. The head is also made in both stationary and rotary types, the stationary type being known as Style E and the rotary type as Style R. The rotary heads can be supplied with taper shanks for use on a drilling machine, or with special shanks to fit various automatic machines.

The head can be opened by simply pulling back on the handle. This permits the machine to be stopped without spoiling the threads already cut. Only one spring is used in the construction of the die, and that is a very heavy coil spring properly tempered and having sufficient strength to insure the positive opening of the die. The die is now made in two sizes only, the ½-inch size having a capacity for cutting threads from ⅛ to ½ inch, and the ¾-inch size having a capacity for cutting threads of from ¼ to ¾ inch.

TAYLOR-SHANTZ BENCH TAPPING MACHINE

The bench tapping machine shown in the accompanying illustration is a recent product of the Taylor-Shantz Co., 478-486 St. Paul St., Rochester, N. Y. This machine is designed for use in tapping threads of all sizes up to and including threads of 5/16 inch diameter. The tap is driven in the required direction for tapping when the work is pressed



Bench Tapping Machine made by Taylor-Shantz Co.

against it, and is automatically reversed when the work is pulled away. A leather-faced disk is employed between the pulleys to minimize the danger of breaking taps. The machine can be driven from the lineshaft with one straight and one cross belt. The bed of the tapping machine is 7⅝ inches by 5 inches; length of the spindle and chuck is 12¼ inches; the pulleys are 5 inches in diameter by 1½ inches face; the height to the top of the pulley is 6½ inches; and the weight of the complete machine is 21 pounds.

WOODALL-BASCH SELF-CENTERING DRILL AND REAMER HOLDER

The Woodall-Basch Tool Co., 450 Weiting Block, Syracuse, N. Y., has recently placed on the market the self-centering drill and reamer holder shown applied to different operations in Figs. 1 and 2. Referring to Fig. 1, center sleeve *A* has a large head through which a T-slot is milled at right angles to its center line. This sleeve can be furnished with a taper shank or a straight shank, as desired. It has a taper-reamed hole to receive a center that takes the place of the regular center of the machine in which the holder is used.

Fitted to float freely in the T-slot in *A* is a head *B* for holding drills or reamers. This head consists of a malleable-iron casting in the form of a collar connected at one end to bar *C* which is a sliding fit in the T-slot in part *A*. Bar *C* is the part that floats in the T-slot in the sleeve. In one side of the collar end of this head is a hardened steel vee, against which the tools are held by means of a headless screw. The hardened and ground steel center fitted to the tapered hole inside sleeve *A* projects through an opening in bar *C* into the opening back of head *B*, and as previously stated takes the place of the regular center for locating the tools on the center line.

When placing a drill or reamer in the holder, the female center of the tool is placed over the male center of the holder.

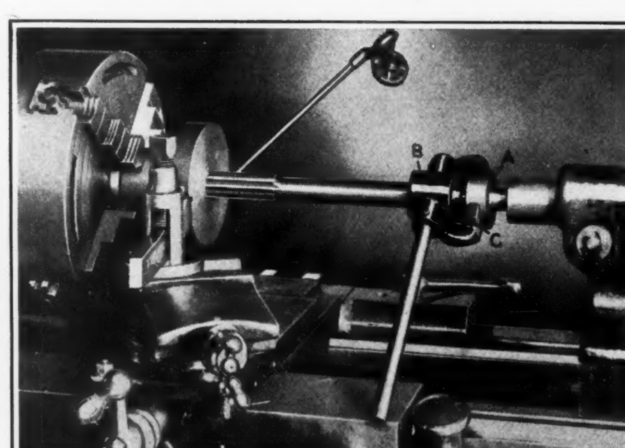


Fig. 1. Self-centering Reamer-holder made by the Woodall-Basch Tool Co.

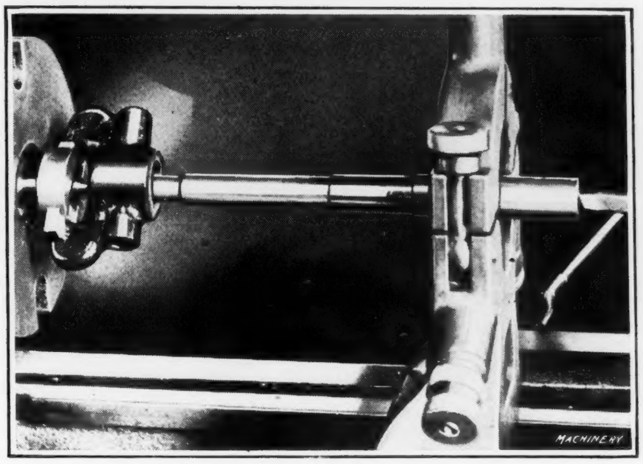


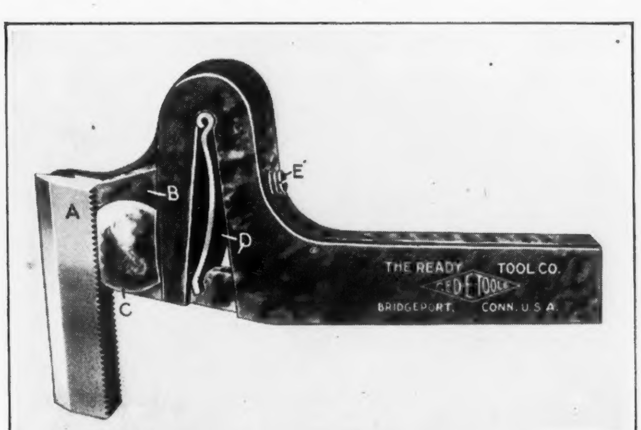
Fig. 2. Self-centering Tool-holder used in Connection with a Steadyrest

The screw in head *B* is then tightened causing the head to float to the tool where it holds it in place and in alignment with the machine spindle.

Fig. 1 shows the holder employed in a reaming operation in a lathe. In this case, the holder is held in the tailstock, a handle being inserted in head *B* opposite the clamping screw to prevent the rotation of the reamer as the tailstock is advanced. When held as shown in this illustration, there is no tendency to produce a tapered hole. As the holder is attached to the tailstock, there is no danger of the drill or reamer slipping off the center, a feature which eliminates tool breakage resulting from this cause. In Fig. 2, the holder is shown mounted in a lathe spindle where it is used as a hold-back in connection with a steadyrest. This method does away with bolts, straps, and belt lacing commonly used in performing centering, turning or boring operations on the ends of shafts. The holder, in this instance, takes the place of a live center, and acts as dog, driver, and hold-back. This holder may also be used for drilling operations.

READY THREADING TOOL

The Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn., has recently placed on the market a spring threading tool in which the familiar gooseneck principle is employed to eliminate chatter and enable the operator to cut smooth threads. Referring to the accompanying illustration, cutter *A* is held at an angle of 15 degrees, and the side angles are accurately ground to cut a 60-degree thread. The cutter being held on the left side of the holder, enables the operator to work close up to a shoulder. The gooseneck construction of the holder permits the tool to spring back slightly on striking hard spots in the work instead of digging in, so that the threaded work may be finished as smoothly with high-speed cutters as with carbon cutters. This feature permits smooth threads to be cut at high speeds.



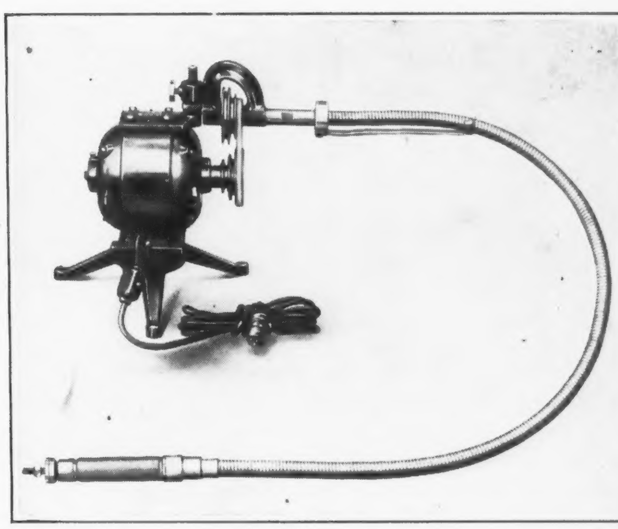
Spring Threading Tool made by the Ready Tool Co.

It will be noted that teeth are cut in the back of the cutter *A*, and also in the front of dog *B*, these two parts being clamped together by bolt *C*, which holds the dog to the tool-holder and eliminates any possibility of the cutter slipping. An auxiliary spring *D* with set-screw *E* is incorporated in the holder. By increasing the pressure on this spring by turning set-screw *E* the holder can be employed for cutting heavy pitched threads such as 4, 6 and 8 threads per inch. When properly adjusted in this manner, the heavier pitched threads can be cut as smoothly as the finer ones.

The top of the cutter only is required to be ground, a feature which permits an inexperienced operator to obtain accurate threads. A Woodruff key is placed in the bottom of the holder to prevent inaccuracies which might otherwise result from side thrust imposed on the tool. This tool can be equipped with V-cutters as well as single-point cutters of the U. S. standard form and cutters of the chaser type. The tool is made in one size only with right-hand offset, the size being ½ by 1 by 7 inches.

HASKINS SWIVEL BASE AND FLEXIBLE SHAFT DRIVE FOR PORTABLE MOTOR

The R. G. Haskins Co., 27 S. Desplaines St., Chicago, Ill., has recently brought out the Haskins new type of swivel base and flexible shaft for portable electric motors, shown



Portable Motor equipped with Swivel Base and Flexible Shaft made by the R. G. Haskins Co.

in the accompanying illustration. Among the new features incorporated in this equipment is a swivel base which allows the motor countershaft to be rotated a full 360 degrees in a horizontal plane. This means that the shaft will always operate in a normal position, and will therefore be less awkward to handle. It also serves to prolong the life of the shaft by reducing the friction caused by operating in a distorted position. Another improvement is the spring support which further reduces the bend of the shaft at the machine, thereby decreasing friction and prolonging the life of the shaft. This support also takes up any strain that might result by pulling on the shaft in any direction.

ST. LOUIS ROTARY PISTON PUMP

The St. Louis Pump & Equipment Co., 321 International Life Bldg., St. Louis, Mo., has recently placed on the market a rotary piston pump designed to handle volatile and non-volatile liquids. Fig. 1 gives a good idea of the compact appearance of the assembled pump, while Fig. 2 shows its simple construction. The pump consists of twelve principal parts: A pump-case *A* (Fig. 2), with a dividing partition *B;* two end plates *C* and *D;* a steel shaft *E* with two eccentrics *F* mounted on it; two pistons *G;* two rocker arms *H;* and two checks *J.*

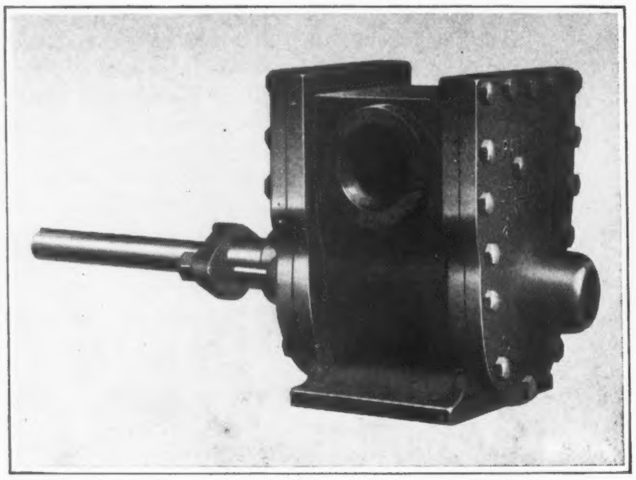


Fig. 1. Rotary Piston Pump made by the St. Louis Pump & Equipment Co.

The two eccentrics F are so keyed to shaft E that their throw is 180 degrees apart; in other words, they are opposed. Surrounding these eccentrics are the two pump pistons G. These pistons are pivoted to rocker arms H, which serve to produce the reciprocating movement of the pistons through the cam action of the eccentrics. In this way the composite reciprocating rotary motion of the pump plunger or piston is obtained without actual contact of piston and cylinder walls. The clearance between the piston and cylinder walls, however, is so small that a liquid seal results, and so positive is its action that after long service it has been found to pull better than 29 inches of vacuum. The piston check J is the only moving part that touches the cylinder wall, and it functions only at the point of transition at the end of the pump suction movement, or stroke, to the beginning of a new stroke. The wear on this check is taken up automatically. The interval between the so-called strokes is so slight that an even impulse is imparted to the liquid being pumped. While the piston is on the discharge stroke it is acquiring fresh liquid on the opposite or suction side, and the piston in the opposite chamber is functioning conversely, thus giving the pump a balanced action.

The pump is constructed entirely of metal, the kind of metal employed being determined by the kind of liquids to be handled. The parts are so arranged that no two similar metals are in contact at any bearing point. All wearing parts are of the rotative type, a feature which tends to give the pump long life. At every point at which wear is likely to occur, even to a minor degree, self-lubricating bearings capable of long service are used. The head at one end of the pump-case is blind; that is, the shaft does not extend through. This construction eliminates the necessity of packing this end. At the other end a gland which holds the packing material is bolted to the head. This gland is separate from the bearing bushing; it is designed to act simply as a gland and does not serve as a bearing, the latter function being restricted solely to the bearing bushing. This pump is compact, light, and is practically free from vibration.

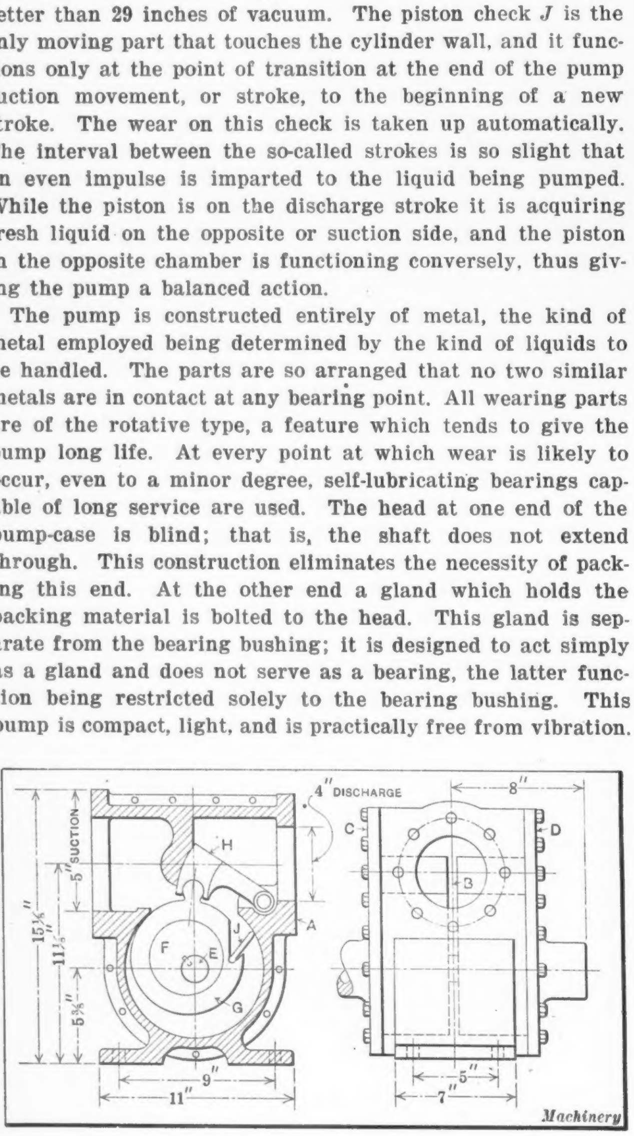


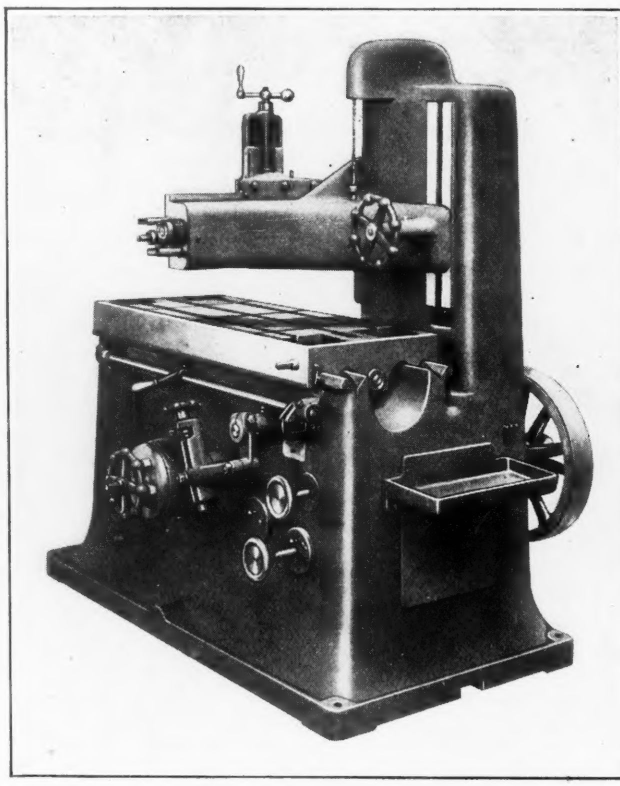
Fig. 2. Diagram showing Construction of Rotary Piston Pump

COULTER SHAPING PLANER

The latest type of Coulter shaping planer built by the Automatic Machine Co., Bridgeport, Conn., is shown in the accompanying illustration. In this machine the quick-return stroke and variable speed of the shaper have been combined with the accuracy and table capacity of the planer to form a tool which is particularly well adapted for tool-room work.

A noteworthy feature of this new product is the combination clutch and brake mechanism, which is operated by a conveniently located lever at the front of the machine. By means of this lever, the table can be stopped and started instantly without stopping the motor or the countershaft. In fact, no countershaft is required where it is possible to belt direct to the machine from the main lineshaft. This feature makes the installation of the machine a comparatively simple matter and is of especial value in shops where the head room is limited.

The clutch and brake mechanism referred to consists of a raybestos-lined brake and a main driving pulley made up of



Coulter Shaping Planer built by the Automatic Machine Co.

two concentric wheels, the inside rim of one and the outside rim of the other being beveled at an angle, which, by repeated tests has been shown to be most satisfactory for the purpose. When, by movement of the operating handle, the clutch is thrown out, the brake is simultaneously applied. The degree of friction in the clutch can be adjusted by means of a split nut on the driving shaft. The large bearing surface of the clutch insures a minimum amount of wear and gives a maximum torque for the minimum friction developed without appreciable heating. An indicator showing the length of stroke is another improvement found on this machine that should prove particularly useful in performing various machining operations required in tool-room work.

VAN KEUREN GAGE-BLOCKS

The Van Keuren Co., 362 Cambridge St., Allston Station, Boston, Mass., has placed on the market a set of "microgages," known as the "OK-VK," giving by combination a standard size for every thousandth of an inch from 0.4 inch to over 5 inches. The set, as shown in the accompanying illustration, is designed especially to meet the requirements

"OK-VK Microgages" made by the Van Keuren Co.

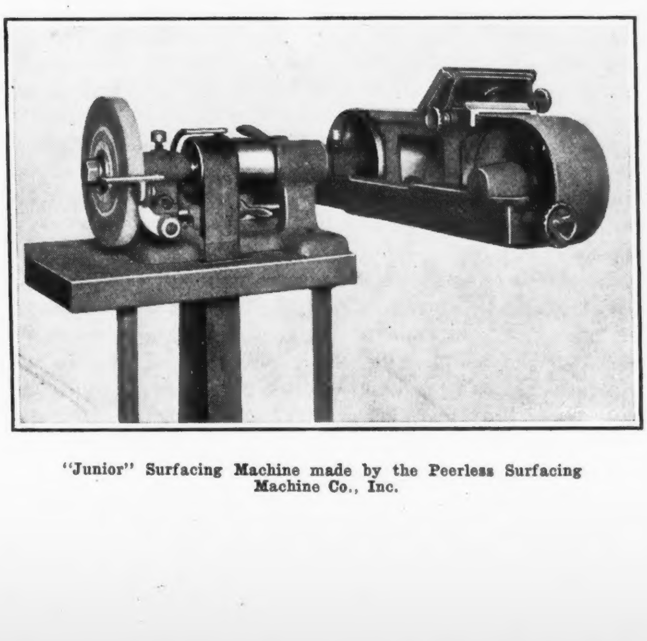
of production departments, small shops, or individual workmen. The obtainable combinations being in thousandths, the set is particularly useful for such purposes as setting sine bars, checking instruments, snap gages, and tools for machining slots, widths, and heights on parts being machined, and for the many uses for which combination gages or size blocks will save time.

The complete set consists of sixteen separate gages which are arranged in four series, each series consisting of four blocks. The thousandth series consists of blocks measuring 0.101, 0.102, 0.103, and 0.106 inch, respectively. The hundredth series consists of blocks measuring 0.110, 0.120, 0.130, and 0.160 inch. The tenth series consists of blocks measuring 0.100, 0.200, 0.300, and 0.500 inch. The inch series consists simply of four 1.000-inch blocks.

The gages are made of high-grade tool steel, scientifically heat-treated and seasoned. They are ground and lapped to a mirror finish, and are standardized by light wave measurement against standards certified by the National Bureau of Standards, Washington, D. C. Each gage is held within a guaranteed accuracy of twenty-five millionths of an inch at the standard temperature of measurement, namely, 68 degrees F. The set is conveniently arranged in a plush-lined leatherette-covered case. Over five thousand standard sizes are said to be obtainable with the set as furnished, and greater range may be secured by adding 1-inch gages to those provided in the set.

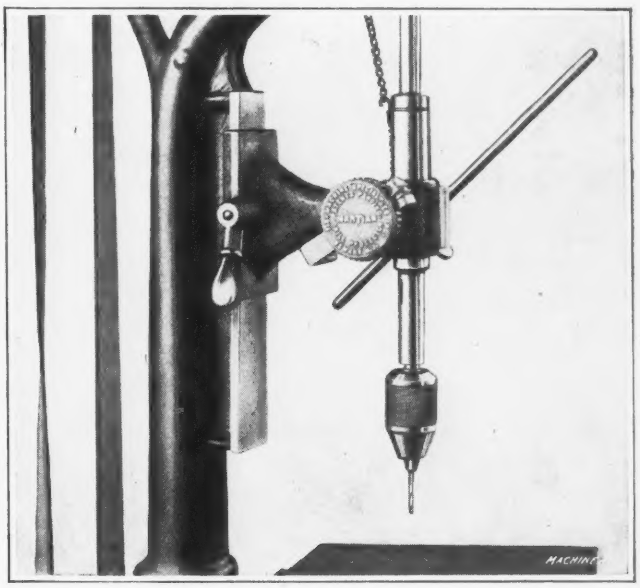
"JUNIOR" SURFACING MACHINE

A general utility surfacing machine known as the "Junior" has recently been placed on the market by the Peerless Surfacing Machine Co., Inc., Troy, N. Y. Referring to the accompanying illustration, it will be noticed that this machine is of compact design and possesses features which make it well adapted for surfacing small parts in machine shops and factories. Although it occupies but little space, it carries a 63- by 4-inch high-speed abrasive belt.



"Junior" Surfacing Machine made by the Peerless Surfacing Machine Co., Inc.

The arm that supports the abrasive belt pulleys can be swung about the center of the driving shaft and clamped in any desired position. This enables the belt surface to be located in a horizontal or vertical position or at any intermediate angle. The machine can be driven from a countershaft, a separate motor, or by direct connection to the end of the shaft. It can also be attached to a table and moved around the shop from one job to another. The main shaft is designed to carry a grinding wheel or disk plate 11 inches in diameter, in addition to furnishing the drive for the abrasive belt. This machine has proved particularly useful for such work as the preparation of mineralogical specimens, the finishing of piano parts, hardware, metal stampings, small castings, switch bases, automobile small parts, and various articles made from hard rubber. The machine weighs approximately 150 pounds and occupies a floor space of 14 by 10 inches. The abrasive belt wheels or drums are 8 inches in diameter by 4¼ inches face width. The belt table is 12⅜ inches by 4¾ inches, and the abrasive belt speed, 2500 feet per minute.



"Martian" Drill Protector made by F-S Machine Specialties, Inc.

"MARTIAN" DRILL PROTECTOR

The "Martian" drill protector shown in the accompanying illustration is a new product of F-S Machine Specialties, Inc., 171 Washington St., Newark, N. J. It is designed for use in connection with sensitive or hand-operated drilling machines for the purpose of preventing drill breakage. Probably 90 per cent of small drill breakage in production work occurs just as the drill breaks through the under surface of the part being drilled. It is claimed that the "Martian" protector will prevent this breakage, but it is not claimed that it will prevent breakage due to incorrect drill grinding or other causes.

The theory on which the design of the attachment is based is as follows: When the drill point approaches the under surface of the work, the resistance of the material rapidly breaks down and unless the operator lightens the feed or carefully feels the way through, the drill will move forward faster than the cutting edges can remove the metal, and instead of acting as a cutting tool the action becomes more like that of a screw; it is under these conditions that small drills are most frequently broken.

The "Martian" protector comes into action just when the drill is about to pierce the under surface, and exerts an upward pressure on the drill spindle, which counteracts the lowered resistance of the work to the advancing drill due to its breaking through. When the protector is properly set,

the operator can detect no change in the "feel" of the press feed-lever, as the resistance is shifted to the mechanism of the protector. The operator simply feeds the drill down until it comes to a full stop, which occurs when the drill is entirely through the work, and the hole completely drilled. This device is primarily intended for use in preventing the breakage of drills varying in size from No. 60 up to 1/8 inch in diameter.

ARTER AUTOMATIC PISTON-RING GRINDER

The Persons-Arter Machine Co., 72 Commercial St., Worcester, Mass., has made it possible, by the application of an automatic attachment, to convert the company's grinding machine into an automatic piston-ring grinder having a capacity for grinding 1400 rings on one side per hour, and capable of handling rings of any size from the smallest up to 4 1/4 inches in diameter on the present model.

The automatic device is so designed that it can be readily attached to any of the company's existing machines by simply drilling one hole through the base of the machine for a rocking bar which operates an air valve by means of which and neutralizes any residual magnetism that may be present at the time of the indexing. When again indexing, the ring is passed over a chute shown in Fig. 1, through which it drops on a rod provided for receiving the rings as shown, and a new ring is placed in position for grinding at the same moment. In the three positions between the discharging of the ring and until the holes in the carrier plate again move underneath the magazine, they perform no function, as the whole purpose of the device is simply to feed piston-rings automatically from the magazine to the grinding wheel, underneath which they are held and rotated by the magnetic chuck, and then to discharge the finished rings as shown.

The wheel-slide of the machine is provided with three speeds, making the capacity from 850 to 1400 rings per hour, but still faster speeds would be possible on the roughing operation if consistent with the finish required. As the machine is entirely automatic in its operation, one operator can run six machines.

The operation of the machine is, briefly, as follows: The rings to be ground are stacked in the magazine, the bottom ring dropping by gravity to the receiving plate and inside the holes in this plate, these holes being provided with interchangeable hardened steel disks for receiving the rings.

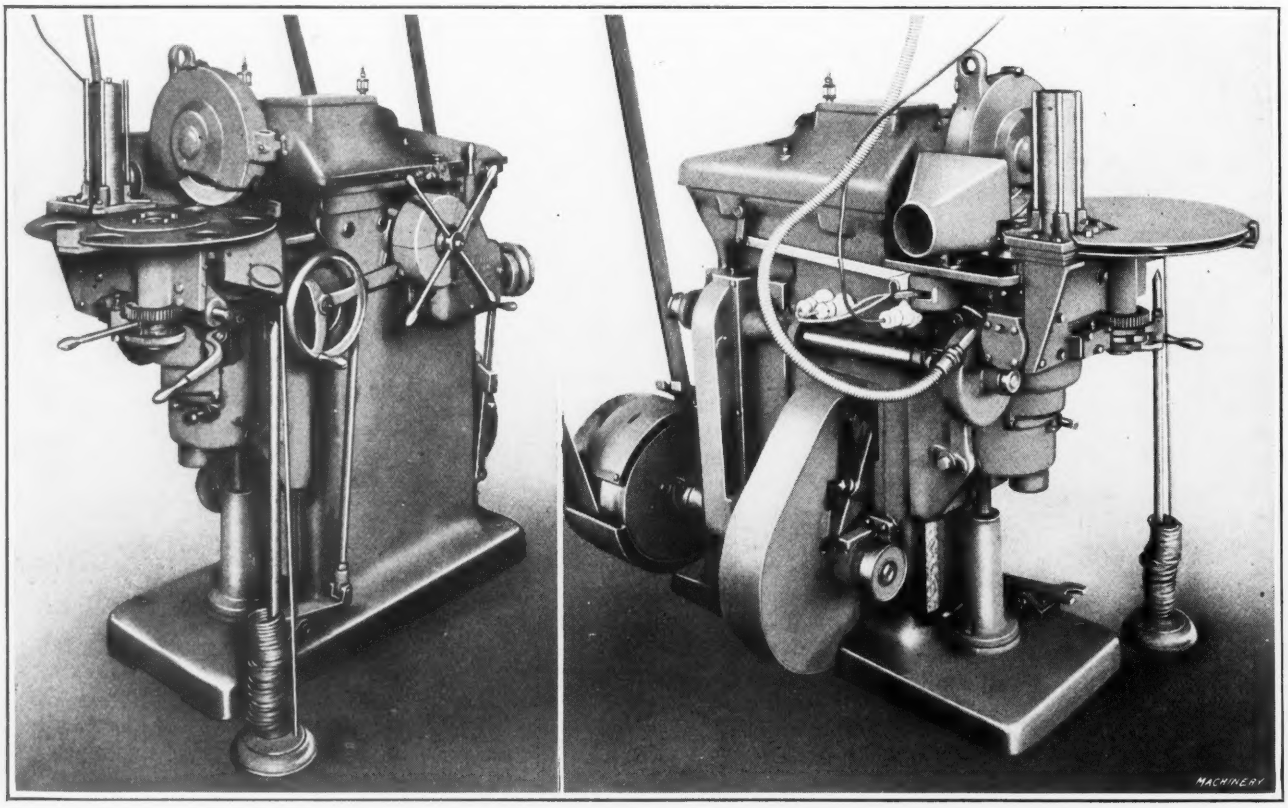


Fig. 1. Persons-Arter Automatic Piston-ring Grinder

Fig. 2. Another View of the Persons-Arter Automatic Piston-ring Grinder

the indexing mechanism of the device is controlled. The frame casting on which the mechanism is assembled, is so designed that the whole mechanism will drop into the same place and be located in the same manner as the water pan on the regular machine.

The accompanying illustrations, Figs. 1 and 2, show the device as applied to the Persons-Arter grinding machine. Fig. 1 shows the carrier disk provided with six holes or receivers into which the piston-rings drop as they pass from the magazine shown, to the grinding wheel. As the carrier disk moves around to the grinding position, actuated by a pneumatic indexing mechanism to be described later, the ring is placed under the grinding wheel and directly above the magnetic chuck regularly provided on the machine, and is held by this magnetic chuck while the grinding takes place.

When the grinding has been completed and immediately before the next indexing movement, a special reversing switch momentarily reverses the current through the chuck These disks are tongued and grooved into the receiving plate and a locking plate prevents them from rotating. The upright bars of the magazine are also adjustable radially to accommodate rings of different diameter. When a new ring has dropped into the hole in the carrier plate, and the grinding on the ring under the wheel is completed, the wheel having reached its extreme backward position away from the ring, the current energizing the magnetic chuck or work-holder is automatically switched off, thereby releasing the ring on the chuck. As soon as this release has taken place, the regular reversing dogs on the machine operate an air valve, thereby admitting air to the cylinder that operates the indexing mechanism through a piston which rotates the gear and cam mounted on the index-spindle shown in the illustrations. The gear and cam are free on the spindle, the latter controlling the movement of a pawl which, in turn, rotates the spindle through a toothed disk or ratchet shown mounted at the extreme lower end of the indexing spindle and which is attached to it. An index-plate just over this

ratchet provides the means of locking the carrier plate in the grinding position, by a plunger sliding into a notch cut in its periphery. In this way any piston-ring resting in the hole in the carrier plate is carried to the center of the magnetic chuck as already described.

When the grinding wheel starts on its forward movement, the magnetic chuck is automatically energized before the wheel touches the piston-ring, this energizing effect being continued until the wheel is in the same position on the backward stroke. As the wheel reaches its furthest position toward the center on the piston-ring, the regular reversing dog on the machine moves the lever controlling the air valve in an opposite direction to that in which it was moved at the end of the backward stroke of the wheel, and the piston in the air cylinder is moved backward, the pawl of the indexing mechanism meanwhile slipping over the teeth in the ratchet gear and being brought into a position ready for a new indexing movement. It will be noted that as the valve is operated from the regular reversing dogs on the machine, it is impossible for the valve and the air cylinder controlled by it to be out of time with the movement of the grinding wheel, so that the indexing mechanism and the automatic forward and return motion of the wheel must always be timed exactly in harmony with each other. Furthermore, the length of stroke of the wheel has no effect upon the action of the indexing movement, as it is controlled directly by the regular reversing dogs of the machine.

The attachment is adjustable in a vertical direction relative to the chuck by merely loosening two screws entering elongated slots and making the adjustment on a screw provided for that purpose at the bottom of the attachment. The regular vertical adjustment of the attachment in conjunction with the chuck, to compensate for wheel wear, is operated directly by the regular vertical feed mechanism, using the handwheel shown. All parts are easily accessible, and the design is such that in any case where parts have to be removed this can be done by loosening the minimum number of screws or nuts.

The wheel may be dressed by dropping a fixture into the place where the ring would ordinarily be held; this fixture is held by the magnetic chuck, and by having a diamond suitably mounted in it, the wheel may be dressed in this way.

In order to eliminate all shock in the indexing movements, an ingenious cushion valve is provided which effectively controls the momentum of the moving parts, and the indexing takes place smoothly and without shock. Chain drive is provided from the main drive of the machine through the universal shaft so as to insure a positive drive for the chuck.

If the air should fail for any reason, the device can be operated by hand by using the lever shown inserted in the cam-plate.

NEWTON DRUM TYPE CONTINUOUS MILLING MACHINES

Various types of continuous milling machines built by the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa., have been previously described in MACHINERY. In the accompanying illustrations are shown two of the latest machines developed by this company for performing surface milling operations in the manufacture of duplicate parts, such as automobile engine cylinder blocks, crankcases, etc. These machines are known as the Model 0-4 and are adapted for machining either one surface on two castings placed side by side or two surfaces on one casting. In both illustrations, the milling machines are shown performing two surfacing operations on each casting. One of the advantages of this method of milling over the method of milling one surface on two castings is that it eliminates one handling operation. Another advantage is that in milling two surfaces at one time on the same casting a higher degree of parallelism is obtained, whereas if the surfaces are machined separately, it is almost certain that there will be a lack of parallelism.

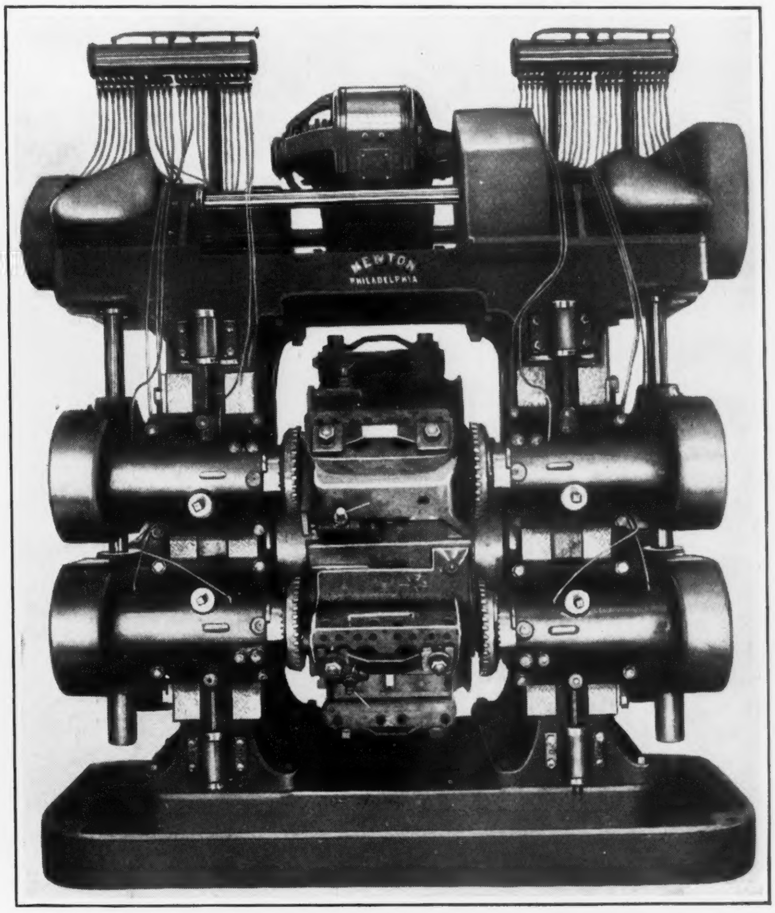


Fig. 1. Drum Type Continuous Milling Machine built by the Newton Machine Tool Works, Inc.

The machine shown in Fig. 1 is equipped for milling or surfacing the ends of cylinder blocks. Two milling cutters are engaged in taking roughing cuts on the opposite ends of one cylinder block, while another pair of cutters is engaged in finish-surfacing the ends of a cylinder block previously rough-machined by the roughing cutters. The machine shown in Fig. 2 is equipped for surfacing the head and the base of a cylinder block. These two surfaces are rough-milled simultaneously by one set of milling cutters while the other set of cutters is finish-surfacing one of the cylinder blocks which has been rough-faced by the roughing cutters.

All spindles have individual adjustment and are driven by worms and worm-wheels, so arranged that the cutting speed of the finishing cutters is 80 per cent of that of the roughing cutters. The speed of the cutters can be varied by means of "pick-off" change-gears. The drum on which the work is mounted is rotated by herringbone gears through a worm and worm-wheel drive, which is also variable by the use of "pick-off" change-gears. The drum spindle is provided with means for making very fine adjustments to prevent end motion, and is also provided with a take-up bushing of the split taper type. All gearing, splined shafts, and revolving parts are fully enclosed, and run in a bath of oil which is pumped from the reservoirs on each side of the machine. The oil, after having passed through the various bearings, returns to the reservoirs. All slow-running members, such as the spindles which are lubricated by pipe connections, have a special system of oiling which prevents flooding, thus eliminating loss of oil and preventing the annoyance resulting from oil leakage.

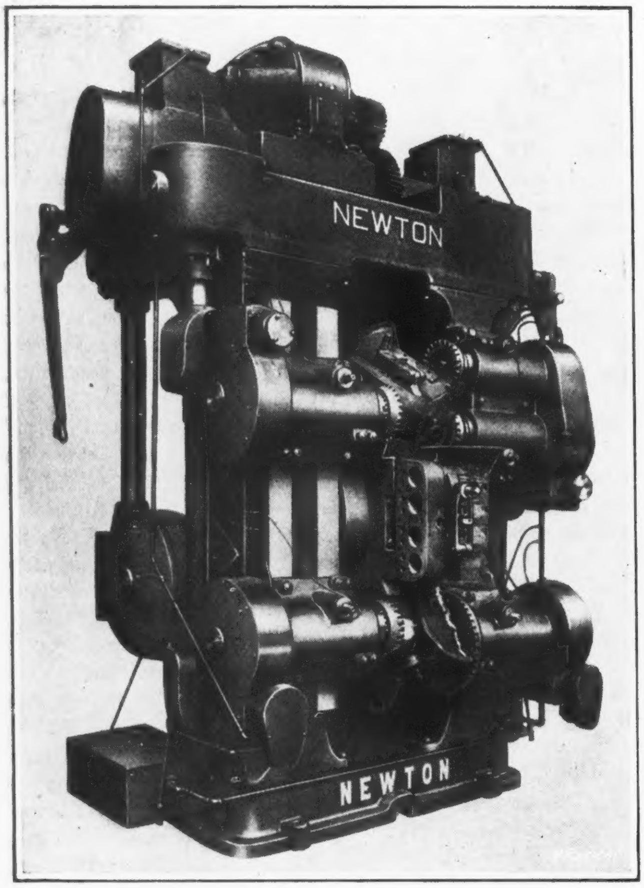
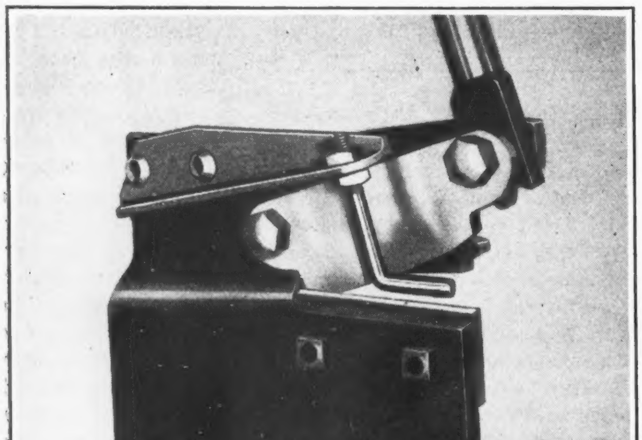


Fig. 2. Another Continuous Milling Machine made by the Newton Machine Tool Works, Inc.

In the chucking of the work, only one clamp as shown in Figs. 1 and 2 is used. It will be noted that the clamp shown in Fig. 1 has a two-point bearing, a feature which simplifies the locating and unloading operation. These machines occupy very little floor space in comparison to their production rates, which in the case of the machine shown in Fig. 1, is thirty-five pieces per hour and in the case of the machine shown in Fig. 2, twenty-five pieces per hour.

DREIS & KRUMP STEEL SLITTING SHEAR

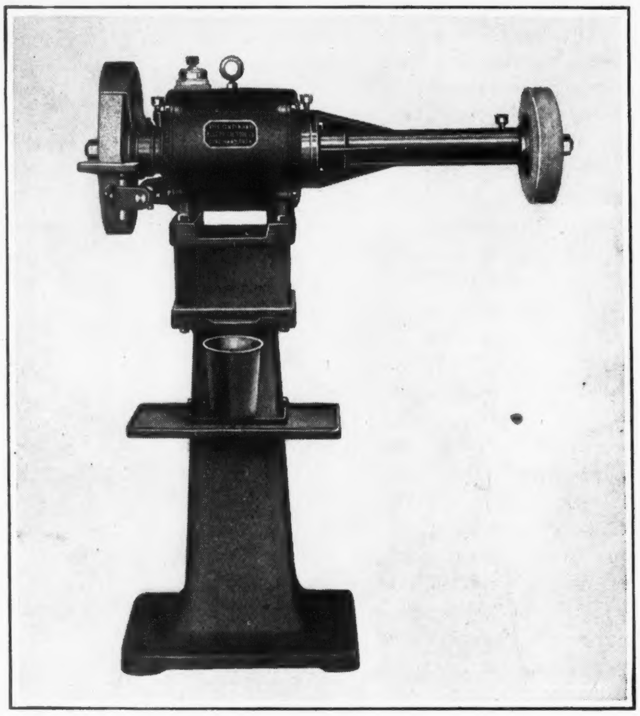
The Dreis & Krump Mfg. Co., 2909-2923 S. Halsted St., Chicago, Ill., has recently placed on the market a device known as the Chicago steel slitting shear. This shear, which is shown in the accompanying illustration, is adapted for slitting or cutting operations on bar stock 2 inches by 3/16 inch and smaller, 10-gage sheet steel, brake band lining, belting, and similar work. The shear is constructed of steel throughout, the frame being pressed from a steel section which gives strength and durability. The knife or cutter is operated by a geared lever which gives great cutting power. An adjustable hold-down is provided as shown. The knives are of crucible steel and all parts are interchangeable. The machine weighs only 22 pounds, and is a very handy tool for all classes of slitting or cutting operations within its capacity, being especially well adapted for use in factories, sheet metal shops, and garages.



Steel Slitting Shear made by the Dreis & Krump Mfg. Co.

COMBINATION GRINDER AND BUFFER

A combination grinder and buffer mounted on a floor stand, which permits interchangeable buffing and grinding without changing wheels, has recently been added to the line of portable electric drills and grinders manufactured by the Cincinnati Electrical Tool Co., 1501-1505 Freeman Ave., Cincinnati, Ohio. As shown in the illustration, the grinding wheel is mounted close to the motor at one end of the motor spindle, while the buffing wheel is carried at the end of a long bearing or extension arm which extends from the opposite end of the motor. The grinding wheel is adapted to both tool grinding and general grinding of all kinds.



Combination Grinder and Buffer made by the Cincinnati Electrical Tool Co.

The motor windings are fully enclosed and protected, and the spindles are carefully ground. Annular ball bearings are fitted on both ends of the armature spindle, as well as at the end of the extension spindle on which the buffing wheel is mounted. Dust caps are fitted to the spindle to protect the bearings and windings from emery dust and dirt. The grinders are fully equipped, including tool board and water pot, and can be furnished without floor pedestal if desired. The motors are made for direct or alternating current in ½-, 1-, 2-, and 3-horsepower capacity to carry wheels from 8 to 14 inches in diameter.

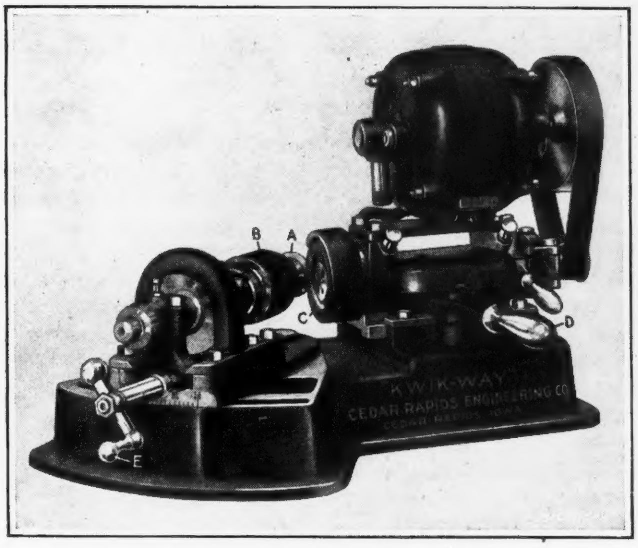
CEDAR RAPIDS VALVE FACING MACHINE

The "Kwik-Way" valve facing machine recently placed on the market by the Cedar Rapids Engineering Co., 902 N. 17th St., Cedar Rapids, Iowa, is built for the purpose of refacing motor valves preparatory to grinding them in by the usual

method. The leakage of motor valves and the consequent loss of compression not only decreases the power and impairs the performance of a gasoline motor, but is also the direct cause of many other troubles usually attributed to incomplete carburetion, faulty ignition, or worn piston-rings. In order to stop the loss of power, and waste of fuel and lubricating oil resulting from leaky valves, it is necessary that the valves be properly reground. In order to do this, the face of the valve should be trued up in relation to its stem, and the valve seat should also be ground to line up with the valve-stem guide. After this has been accomplished, the valves must be ground in with a fine grinding compound. By the use of the valve facing machine here illustrated, valve seats can be quickly and accurately trued up so that the final grinding-in operation will require but a moment.

Referring to the accompanying illustration, the valve A which is to be ground is held by a specially designed chuck B and rotated while the face is being trued up with the high-speed grinding wheel C. The base of the machine is a one-piece casting heavily ribbed and reinforced to insure rigidity and freedom from vibration. The grinding wheel shaft or spindle is hardened and ground to an accuracy of one-half thousandth of an inch, and runs on ball bearings made dust-proof and packed in grease. The grinding wheel is of special shape and grit produced expressly for this machine by the Norton Co., and is regularly carried in stock.

The special chuck is really two universal three-jaw chucks in one, with each chuck working independently of the other. This specially designed and patented chuck centers the valve



"Kwik-Way" Valve Facing Machine made by the Cedar Rapids Engineering Co.

stem at two points, 2½ inches apart, on that section of the valve stem that works in the valve guide. This insures accuracy in centering a used valve for refacing. The chuck and chuck shaft are one unit. All parts are hardened and ground, and the chuck shaft runs in reamed bearings, which are adjustable for wear, and is driven at a speed of 200 revolutions per minute by worm-gearing from the grinding wheel shaft, which has a speed of 6000 revolutions per minute. Both the grinding wheel shaft and chuck shaft are mounted on sliding carriages, the ways of which are gibbed to compensate for wear.

The grinding wheel is moved across the face of the valve by means of a hand-lever D at the front of the carriage. The adjustment of the valve relative to the face of the grinding wheel is accomplished by turning the small crank E at the left end of the chuck carriage. This machine will take any size valve up to and including one having a 3-inch head, and a stem ½ inch in diameter. By means of graduations the machine can be set to grind any angle from 25 to 65 degrees. The machine is driven through a friction clutch pulley on the grinding wheel shaft by means of a motor.

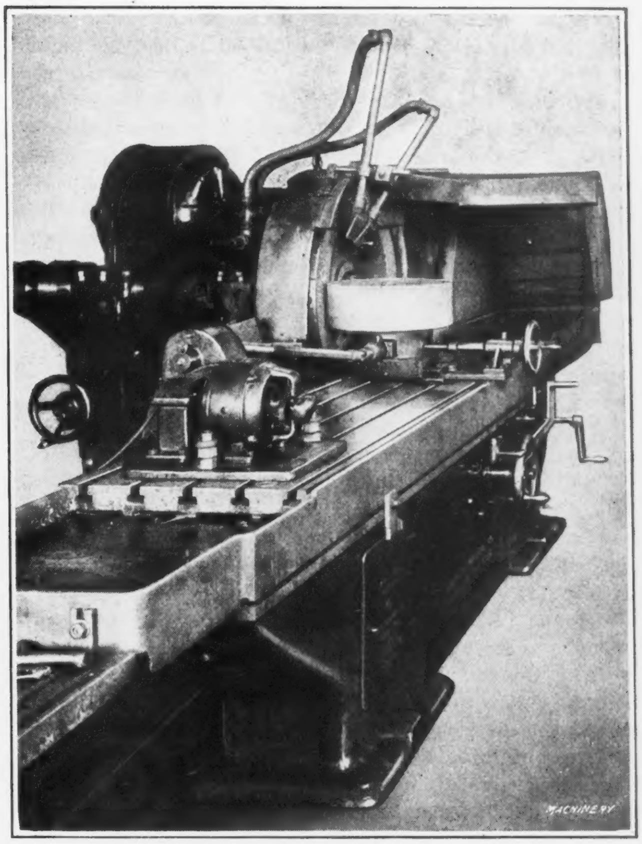


Fig. 1. Crowned-pulley Grinding Attachment applied to a Diamond Heavy-duty Face Grinding Machine

DIAMOND CROWNED-PULLEY GRINDING FIXTURE

The crowning of pulleys by grinding may be done by using a formed wheel covering the entire face of the pulley or by using a straight-face wheel; in the latter case either the wheel or the work is set at an angle to form the crowned face. A third method of crowning, which is the one to be described, differs from those just referred to in that a ring or cylinder wheel is employed instead of an ordinary disk wheel. A fixture used in conjunction with this third method has been brought out by the Diamond Machine Co., Providence, R. I. This fixture is shown in Fig. 1 applied to a Diamond heavy-duty face grinding machine. The diagram, Fig. 2, illustrates how the pulley is ground with a wheel of this kind, and also how the amount of crown is varied by changing the position of the pulley relative to the wheel. If the pulley is rotated inside of the wheel or in position A, the crown will have the same radius as the inside of the wheel, and the amount of crown can be reduced to zero as the position of the pulley is changed from A to B. It is even possible by this method to obtain a negative crowning or a concave face by rotating the pulley against the outside of

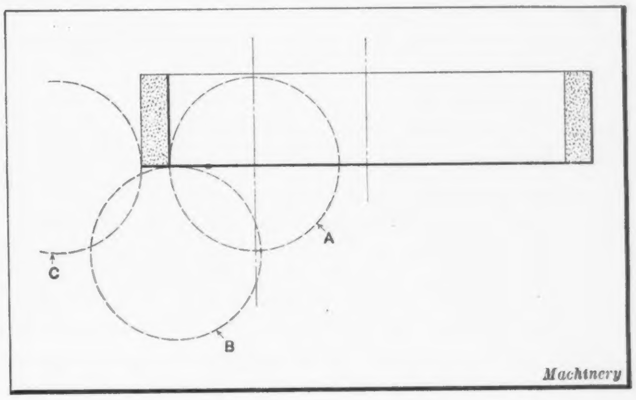


Fig. 2. Diagram showing how Amount of Crown is varied by changing Position of Pulley Relative to Wheel

the wheel, as indicated at *C*. While concave faces are not required for pulleys, this feature might be of value for other classes of work.

The faces of the pulleys are ground from the rough, although the pulleys are chucked and the edges finished preparatory to the crown-grinding operation. As Fig. 1 shows, this fixture consists of two units. One unit is composed of the motor with its reduction gearing, and the other is the work-holding member, the two being connected by a universal-joint shaft. The work-holding member has a faceplate with driving pins or dogs that enter between the pulley spokes, and there is also a vertical spindle, the diameter of which is made to fit the hole in the hub of the pulley. The base of the work-holding member is free to slide, and is adjusted relative to the grinding wheel by the handwheel seen in Fig. 1. A slight change will enable this fixture to be adapted for grinding webbed pulleys.

The production obtained with this method of grinding pulleys varies somewhat, according to the amount of stock to be removed and the uniformity of the castings. When grinding pulleys having a diameter of 12 inches and a face width of 4 inches, an average production time, from floor to floor, of two or three minutes is readily obtained. Pulleys 18 inches in diameter with a 5-inch face width have been ground in four minutes, which is the time from floor to floor, but a better average would be six to eight minutes. Face widths as great as 10 inches have been ground successfully by this method. Pulleys 24 inches in diameter and with an 8-inch face width were ground in six and one-half minutes, and a day's production can be maintained at the rate of one in twelve minutes.

Since pulley castings are usually very thin and often chilled, they are frequently difficult to machine; and if the work is done on some type of lathe, low speeds and feeds are often necessary and the percentage of breakage may also be high. Owing to these difficulties, it is believed that the grinding method just described will find favor in many places where the machining of pulleys has heretofore proved to be a somewhat difficult and expensive operation. This general method of grinding can also be applied successfully to the grinding of malleable-iron brake-shoes, rollers for conveyors, wheels for small trucks, and similar work.

MARQUETTE PRESSURE LOCKING DEVICE

In the operation of a double-action power press, the regular cycle of movements is as follows: First, the blank-holder

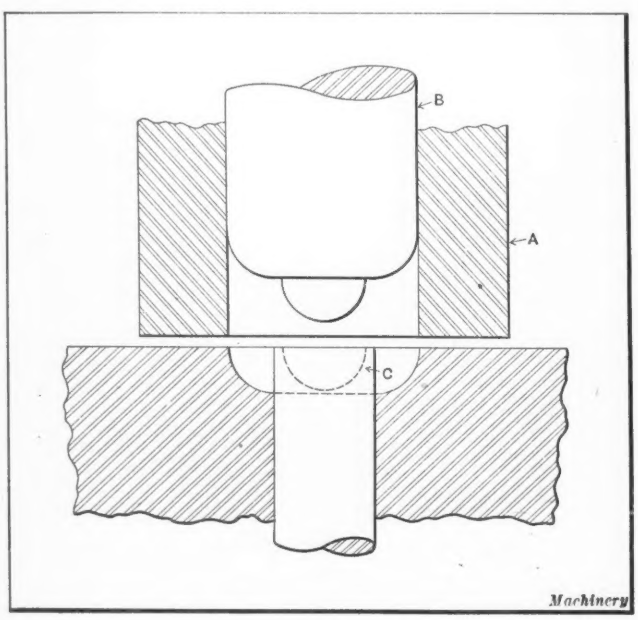


Fig. 1. Diagram showing Arrangement of Upper and Lower Dies and Blank-holder

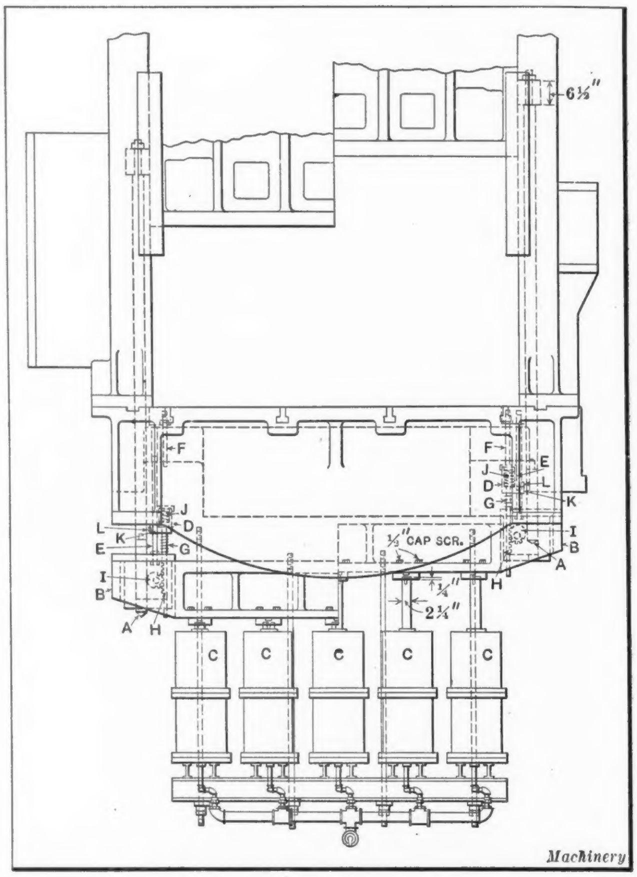


Fig. 2. Marquette Pressure Locking Device shown with the Power Press Ram in its Upper and Lower Positions

descends on the work; second, the upper die descends to perform the required operation; third, the upper die returns to its starting position; and fourth, the blank-holder is raised. This sequence of movements works out satisfactorily with the equipment ordinarily used on a press of this type, but the application of a pneumatic die cushion of the kind made by the Marquette Tool & Mfg. Co., 319-331 W. Ohio St., Chicago, Ill., makes it necessary to provide special means of controlling the movement of the lower die in such a way that it descends independently of the so-called pressure-ring or blank-holder, and is locked to this member during the return stroke.

From the following description, it will be apparent that if such provision were not made, the action of the pneumatic cushion would cause it to raise the lower die member as soon as the pressure of the upper die was released, and thus distort the work which is still held down by the die-holder. This difficulty is overcome by having the lower die and the blank-holder locked together for their return stroke in the manner previously mentioned. Having made this preliminary statement of the purpose of this mechanism and of the way in which it functions, we are in a position to enter upon a detailed description. Attention is first called to the diagram Fig. 1, which shows the outline of upper and lower die members and of the blank-holder for drawing a sheet-metal part.

In conformity with the stated sequence of operations, these members will function as follows: Blank-holder *A* descends on the work; next upper die *B* descends, carrying the center member *C* of the lower die with it; then upper die *B* returns to its starting point; and finally, the blank-holder *A* returns to its starting position. This is the regular sequence of operations, but it will be evident that as center member *C* of the lower die is supported by one of the Marquette pneumatic cushions, it will tend to return to the starting position with the upper die *B*; and as blank-holder *A* does not rise at this time, the work would be destroyed by such a method of operation. But if die member *C* drops independently of blank-holder *A*, but rises with it, no difficulty will be experienced in using the die cushion. It is this control of movements of

the upper die and blank-holder that is accomplished by the device which is here described.

Fig. 2 shows the locking mechanism in two positions. Various parts of this mechanism are shown at the left-hand side of this illustration in the positions which they occupy at the conclusion of the downward stroke of the press; and at the right-hand side, the press has returned to its starting position and the lower die member has been released from the blank-holder, ready for the next stroke of the press. On the first stage of the downward movement of the press ram, two locking bars *A*, which are secured to the blank-holder, move freely through openings provided in the ends of pressure-beam *B* for that purpose. Also, it will be seen that the pressure-beam is supported by pneumatic cushions *C* which resist downward movement of the lower die members. At the conclusion of the first stage of the ram's downward movement, the blank-holder and bars *A* have reached their lowest position. When the second step of the downward movement causes the lower die member *C* of Fig. 1 to descend, pressure-beam *B*, Fig. 2, is also depressed through the action of the upper dies on the corresponding lower die members.

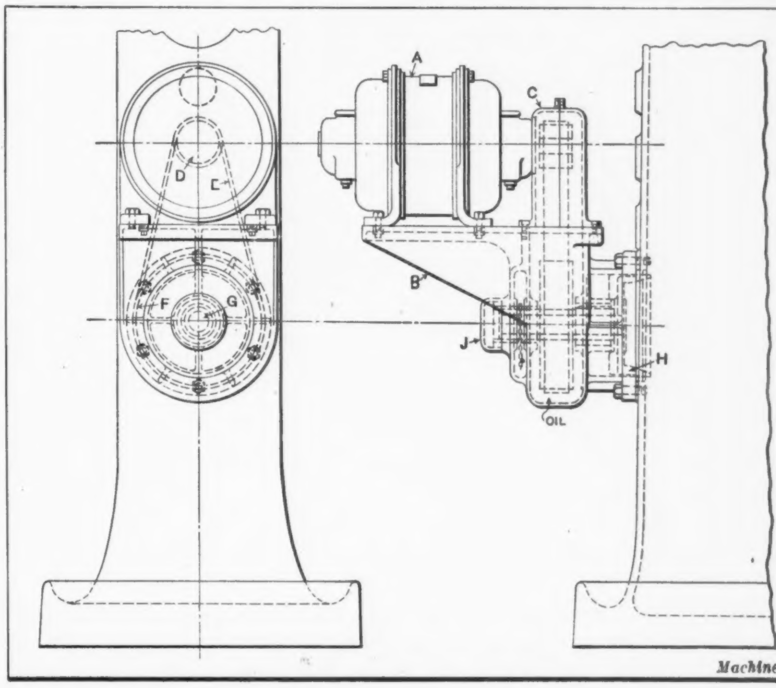
In the initial position of the mechanism, two cylindrical spring housings *D* are in contact with set-screws *F* carried by the bed of the press, and connecting springs *G* are compressed between the top of pressure-beam *B* and the bottoms of housings *D*. When the pressure-beam descends, springs *G* are free to expand, and by lifting housings *D* they cause an upward movement of two racks *H* that mesh with cams *I* which have teeth cut in one side to mesh with the teeth of racks *H*. As the pressure-beam *B* drops, the tendency of springs *G* to lock cams *I* against locking bars *A* is retarded by frictional resistance of the sliding movement of cams *I* on bars *A*; but when the pressure-beam has reached the bottom of its travel, the full force of springs *G* becomes effective in locking bars *A* by means of the cams *I*. At this point, the dies have completed their drawing operation and the press is ready for the return of its various members to their starting positions.

As previously stated, the first step in the upward motion is the return of the upper die to its starting position. When this takes place, cams *I* have locked the pressure-beam *B* and the lower die members carried by it to rods *A* that are secured to the blank-holder; and as a result, die cushions *C* cannot cause the lower dies to rise and destroy the work. Next in the sequence of operations comes the return of the blank-holder and its lower dies to their starting positions, and when this takes place bars *A* and pressure-beam *B* rise together, until such a time as the tops of housings *D* come back into contact with set-screws *F*, arresting the upward movement of housings *D* and thereby causing the springs *G* to be compressed during the further upward movement of beam *B*. The locking friction between cams *I* and rods *A* prevents any movement of racks *H* which continue moving with beam *B*, thereby compressing springs *J* until beam *B* reaches the bottom of the press bed. At this instant the upward movement of beam *B* is arrested, but rods *A* continue their upward movement thus releasing the frictional resistance between cams *I* and rods *A*, and allowing compressed springs *J* to act on the head of racks *H*, turning cams *I* out of contact with rods *A*, as shown on the right-hand side of Fig. 2.

A complete cycle of movements of this mechanism has been described in the foregoing, but it is also necessary to make provision for releasing the pressure of pneumatic cushions *C* at the time that dies are being changed. Otherwise, releasing of this pressure would cause pressure-beam *B* and the lower die members to fall and lock the mechanism. This is prevented by having a small yoke *K* at the side of each housing *D*, through which rod *E* projects. On each of the two rods *E* there is a key *L*, and before releasing the pressure from cushions *C*, the squared upper end of each rod *E* is gripped with a socket wrench, while in the position shown at the right-hand side of Fig. 2, and the rod is turned so that key *L* engages the upper side of yoke *K* and prevents the compression springs *G* from raising racks *H*, and thus turning the locking cams *I*. When held in this manner, the pressure may be released from the air cylinders *C* and the dies changed; then when the necessary adjustments have been made, the keys *L* are turned back so that they slide through the spaces in yokes *K*, thus enabling the press to function in its normal manner.

MOTOR DRIVE FOR CLEVELAND MILLING MACHINES

The Clark-Mesker Co., 18511-18517 Euclid Ave., Cleveland, Ohio, has recently developed a motor drive for the No. 1 and No. 2 Cleveland milling machines. This drive is attached to the milling machine as shown in the accompanying illustration. The regular pulley housing is removed and the bracket flange bolted to the machine in its place. The motor *A* is supported on the flat surface of bracket *B*, and is secured to it by means of four cap-screws. This arrangement makes the motor easily accessible, brings it up away from dirt and chips that gather on the floor, and at the same time does not make the machine top-heavy or give it an unbalanced appearance. This method of attaching the motor to the machine base also eliminates the necessity of providing overhead belts and countershafts. It therefore simplifies the work of installation, and in many cases permits the machine to be used where it would be difficult to install a belt drive.



Motor Drive for Cleveland Milling Machines, developed by the Clark-Mesker Co.

From the end of the motor spindle, which extends into housing *C*, power is transmitted by means of a sprocket *D*, a Morse silent chain *E*, sprocket *F*, shaft *G*, and clutch *H*, to the main drive shaft of the machine. An adjusting nut *J* is provided for adjusting friction clutch *H*. The incorporation of the friction clutch in the drive permits slippage in case the machine should be suddenly overloaded. A 5-horsepower motor running at 1200 revolutions per minute is recommended for the No. 1 milling machine, and a 7½ horsepower motor of the same speed for the No. 2 machine. The silent chain runs in oil, and the motor can be adjusted to take up wear on the chain.

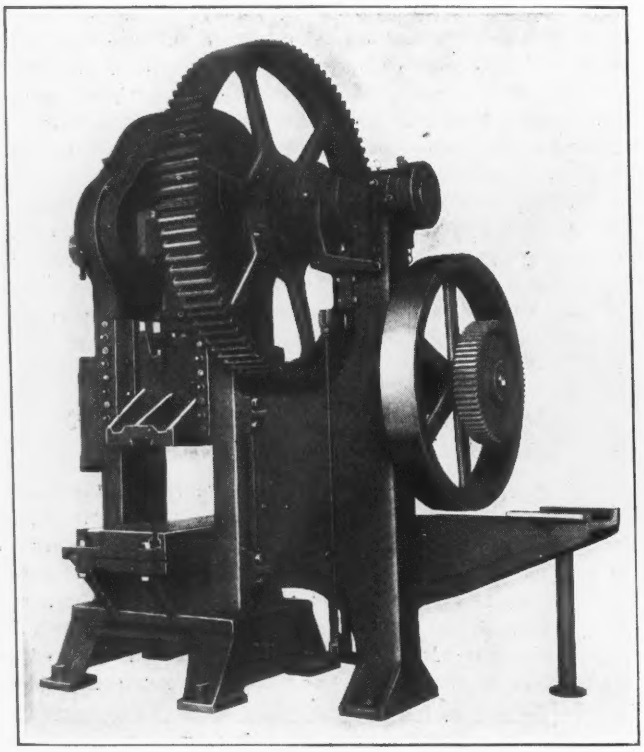


Fig. 1. No. 6 Straight-sided Trimming Press built by Williams, White & Co.

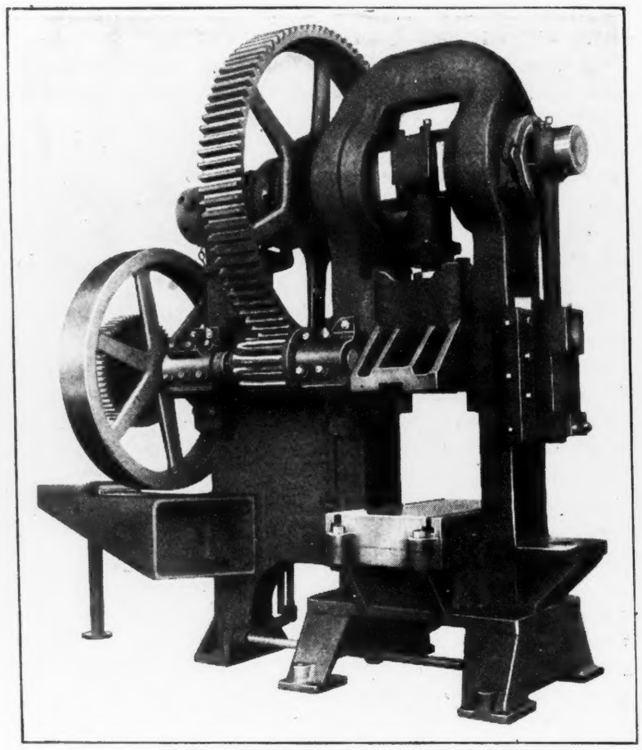


Fig. 2. Rear View of Straight-sided Trimming Press, showing the Outside Slide

STRAIGHT-SIDED TRIMMING PRESSES

The line of straight-sided trimming presses manufactured by Williams, White & Co., Moline, Ill., has recently been redesigned, and a larger press known as the No. 6 has been added. While these machines are primarily intended for trimming flashings from drop-hammer forgings, they are also adapted for perforating, blanking, embossing, stamping, redrawing and similar operations, owing to the large table and ram face areas. The accuracy resulting from the use of exceptionally large hand-scraped guide surfaces and the provision of gibs to take up wear makes possible the use of high-grade dies.

The frames of the machine are made of semi-steel. The outside slide is a convenience when auxiliary operations are to be performed. Steel gears with cut teeth are used. The automatic clutch is of ample size, and its operation positive and quiet. On the No. 6 machine it has six teeth, and is 21 inches in diameter. A screw adjustment mechanism in the pitman moves the ram up or down to adjust the die space to suit the work. The bushed pin connection between the ram and the pitman simplifies adjustments and repairs. The thrust end of the pitman works in a bronze-lined steel block. A leather-lined brake is provided on the main shaft. Motor or belt drive may be supplied. With the latter type, the flywheel serves as a tight pulley. The illustrations show a solid-frame construction, but a tie-rod construction can be furnished if preferable.

ROCKFORD AUTOMATIC LATHE

The accompanying illustrations show front and rear views of an automatic lathe now being manufactured by the Rockford Machine Tool Co., Rockford, Ill., which is especially adapted for machining pistons, pulleys, cone pulleys, gear blanks, and other work where multiple tools can be used for turning and facing operations performed at the same time. The machine was designed along the lines of a 22-inch heavy-duty lathe to insure absorption of vibration and to withstand the most severe service likely to be demanded. It is provided with three changes of speeds obtained by operating a gear-shift lever. The main driving gears of the machine are of the helical type to secure a smooth and powerful drive. The machine has a positive geared feed, driven direct from the spindle through a train of spur gears, the lower two of which are changeable so that variations of feed may be obtained. The headstock is cast integral with the bed.

The front or turning carriage is mounted on a bar 3½ inches in diameter, provided with long bearings in both the headstock and tailstock, the outer end of the carriage being supported on a hardened steel way

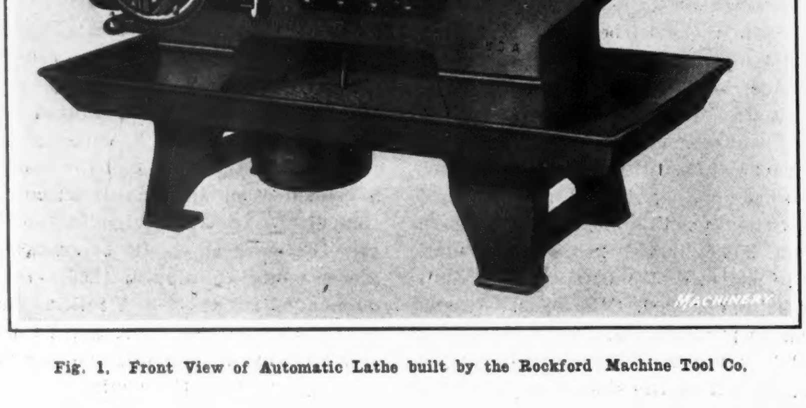


Fig. 1. Front View of Automatic Lathe built by the Rockford Machine Tool Co.

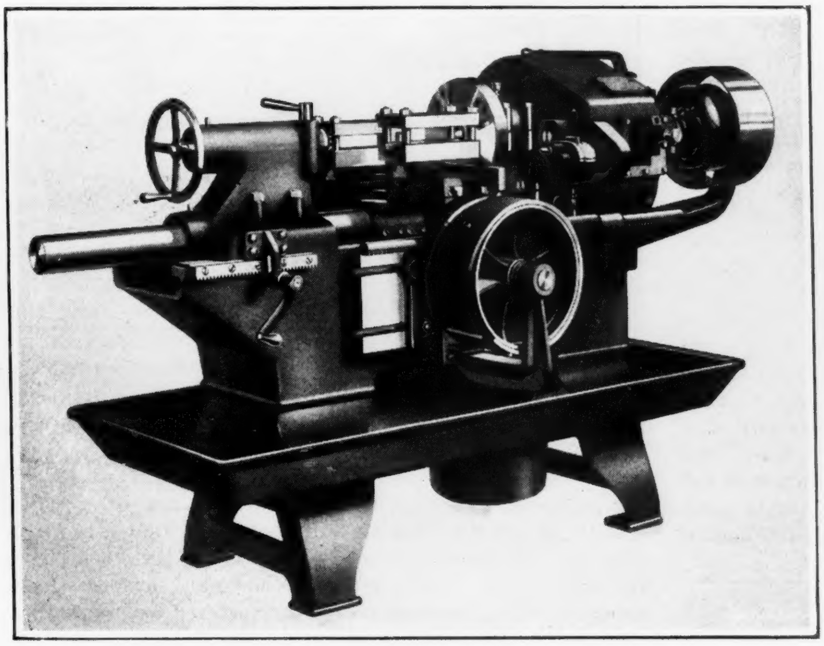


Fig. 2. Rear View of Automatic Lathe shown in Fig. 1

which can be machined to give the work a taper, convex, or concave form. Rack teeth cut in the carriage bar mesh with the cross-spindle of the machine for obtaining the feed. A worm and worm-wheel driven direct from the feed gears furnish power to the cross-spindle, the worm being mounted in a drop frame so that the feed may be ended at any predetermined position.

The back or facing head is mounted on a bracket at the back of the machine and is adjustable longitudinally to accommodate the work. Both the turning and facing carriages are provided with suitable tool-blocks so that a number of tools may be used at the same time. The power feed for the facing head is obtained through a cam-drum which may be clearly seen in Fig. 2 and which is driven from the cross-spindle by a rack and pinion, enabling both the turning and facing heads to be controlled by the same stop. By this arrangement, the time required to finish an operation is equal to the time necessary for taking the longest cut. Various cams may be mounted on the drum so that it is possible to secure different feeds on the rear head from those provided by the feed gears for the turning head.

The tailstock has a quick-acting spindle for releasing the center, and is moved longitudinally on the machine by a rack and pinion. The bed has an oil-pan for coolant which is fed to the work by a pump driven from the pulley shaft. The machine can also be furnished with motor drive, the motor being connected direct to the pulley shaft by means of spur gears. Some of the principal dimensions of this machine are as follows: Swing over turning carriage bar, 14 inches; swing over facing carriage, 10½ inches; maximum distance between centers, 18 inches; and travel of turning carriage, 12 inches. The weight of the machine is about 3500 pounds.

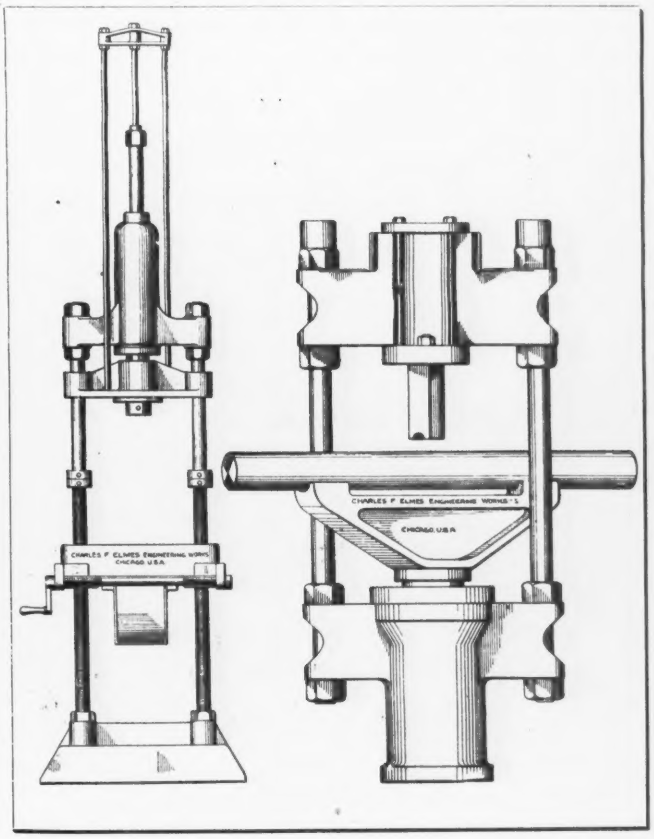
ELMES HYDRAULIC PRESSES AND PUMP

Several new hydraulic presses have been developed by the Charles F. Elmes Engineering Works, 222 N. Morgan St., Chicago, Ill. The press shown diagrammatically at the left of the accompanying illustration, was designed for rapid broaching and will accommodate work requiring pressures up to twenty tons. The distance between the columns is 18 inches, and the platen or table may be raised and lowered quickly by means of the crank at the left. The minimum height between the ram and the platen is 14 inches, and the maximum, 36 inches. A removable plate set in the platen has an opening through it for the broaches. This plate may be replaced by others having any desired size of opening.

A hopper below the table receives the broaches as they pass through the work and the table. The ram is hydraulically operated and is returned to its uppermost position by means of a hydraulic pull-back. The operation of the press is controlled by a single lever valve, and the speed of operation can be regulated to suit conditions. The ram may be stopped at any point of the stroke, this arrangement giving an accurate control at all times. From fifteen to twenty-five strokes per minute may be made with this machine.

The combination hydraulic shop press which is shown at the right in the illustration is known as the "Five-in-one" and was designed to meet the demand for an inexpensive all-around press to be used in small shops or for repair work, etc. This press is suitable for a large variety of forcing, bending, straightening, and broaching operations requiring pressures up to fifty tons. The illustration shows it being used as a straightening press and provided with a removable straightening attachment. When this attachment is removed, the press may be employed as a vertical forcing or arbor press. By adding the proper platens, the press may also be used for forming or compressing operations, and by removing the side bars and the top head, a fifty-ton jack is obtained. On account of its light weight, this machine can be readily employed as a portable press, and used in either vertical or horizontal positions. The press weighs about 500 pounds; the distance between the columns is 18 inches, and the distance from the ram to the top head is about 20 inches.

A high- and low-pressure hydraulic pump which will give a pressure up to 5000 pounds per square inch on the high-pressure plunger and up to 250 pounds per square inch on the low-pressure plunger is also being manufactured by this concern. The pump is so designed that a ¼-horsepower motor will operate it at a speed of 100 revolutions per minute. It is arranged to shift automatically from low to high pres-



Hydraulically Operated Presses built by the Charles F. Elmes Engineering Works

sure when the limit of the low pressure has been reached. This feature enables the pump to raise the ram of the press up to the work at low pressure with considerable speed, and as soon as the ram reaches the work and the resistance is increased to the amount for which the low-pressure plunger is set, the automatic valve lift permits the high-pressure plunger to continue the working stroke of the ram. The pump is provided with a 1½-gallon tank for oil or water, and has a direct-connected motor.

CRUBAN THREADING TOOLS

Several novel thread-cutting appliances have recently been introduced by the Cruban Machine & Steel Corporation, 63 Duane St., New York City. At *A* in Fig. 1 is shown a single-point threading tool holder intended for cutting any style of thread. The tool is held by means of a set-screw in a swiveling block, which can be turned through an arc of sufficient magnitude for the tool to clear the work, this movement being accomplished by operating the knurled handle.

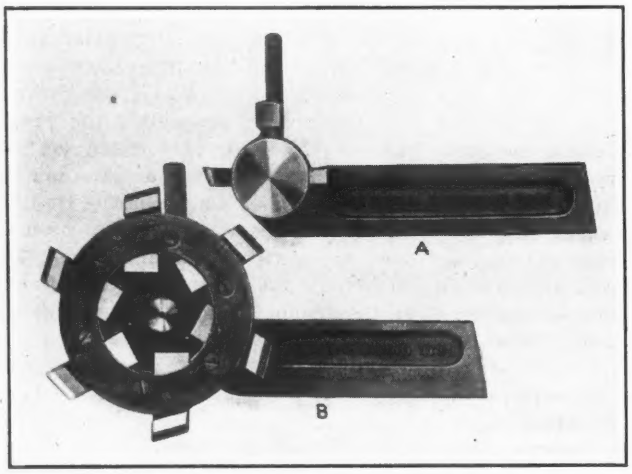


Fig. 1. Single-point and Multiplex Threading Tools made by the Cruban Machine & Steel Corporation

Thus, in cutting a thread, after the tool has been traversed across the work, the position of the cross-slide relative to the center of the work, need not be altered in order to return the carriage to the starting position prior to taking another cut. It is only necessary to tilt the tool in the manner described, and the carriage can be moved along the work without experiencing any interference between the threads and the tool.

The multiplex threading tool holder shown at *B* was designed for cutting any size or style of thread without necessitating a readjustment of the cross-slide during the entire operation. The holder is provided with six tools, each of which extends a certain amount farther from the center of the tool than the preceding one. The circular part in which the tools are mounted can be rotated by operating the knurled handle, and is provided with twelve equally spaced saw teeth

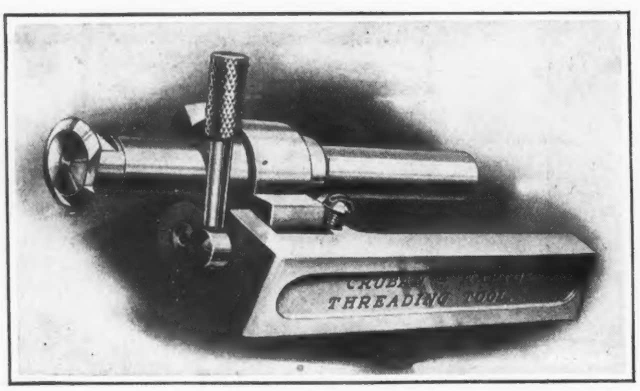


Fig. 2. Internal Threading Tool provided with Circular Cutter

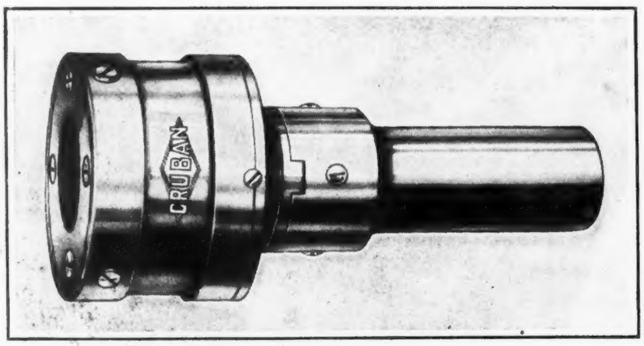


Fig. 3. Releasing and Floating Tap- and Die-holder which is Self-aligning and has Hollow Shank

at the back, into which a plunger operates, so that each of the tools can be held in the proper position for taking a cut or at such an angle that it clears the thread. Thus, in cutting a thread, tool No. 1 is fed across the work, after which it is tilted and the carriage returned to its original position. Tool No. 2 is then fed across the work, the cycle being continued until the thread has been completely formed. Each bit is adjustable and can be readily removed for regrinding. Chasers can also be used in the tool.

An internal threading tool is illustrated in Fig. 2. The circular threading tool used in this case can be tilted from the work after it has reached the end of the cut, so that it can be returned to its starting position without marring the thread that has been cut.

The particular feature of the releasing and floating tap- and die-holder shown in Fig. 3 is that it is self-aligning. After a set-up on an automatic screw machine or turret lathe has been in use for some time, the various tools are likely to have changed their location to such an extent that the work is spoiled when the tap or die used in threading the part comes into contact with it. With this holder, however, this danger is entirely eliminated. A hole is provided through the shank of the holder so that a thread may be cut for an indefinite length, depending upon the travel of the machine carriage. The holder can be employed for cutting either left- or right-hand threads by using suitable dies. No adjustments are required when inserting these dies.

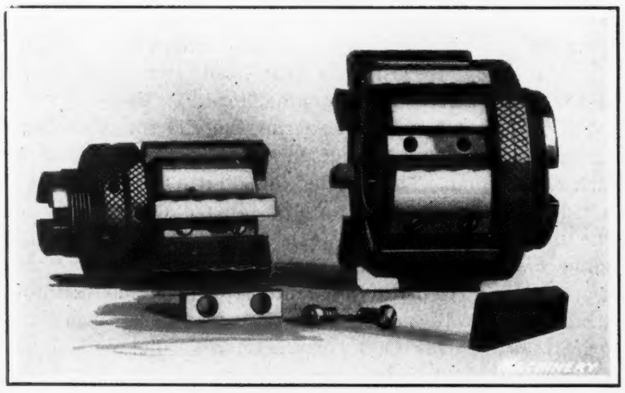


Fig. 1. Reamer having a Double Adjustment, made by the Cleveland Cutter & Reamer Co.

CLEVELAND ADJUSTABLE REAMERS AND INSERTED-TOOTH CUTTERS

The Cleveland Cutter & Reamer Co., 1619 Merwin Ave., Cleveland, Ohio, is now manufacturing an adjustable reamer of the design shown in Fig. 1. This reamer has a double adjustment; thus by screwing back the lock-nuts at the ends of the blades 5/16 inch, an adjustment of 0.083 inch may be obtained; then, by placing the blades up one step they may be again adjusted 0.083 inch. The adjustment can be continued until the blades are worn out, when they are replaced with a new set. These reamers are furnished with blades which are set in the body straight or parallel with the axis, as shown in the illustration, but reamers having spiral or

inclined blades may be obtained at slight additional cost. These reamers may also be equipped with a floating movement.

An inserted-tooth side milling cutter now being made by this company is shown in Fig. 2. The blades are serrated or corrugated on the back to eliminate slipping and tilting as well as packing under the blades. As the result of this method of holding the blades, it is claimed that they can be moved out an unusual length and still be held rigidly. All blades are interchangeable.

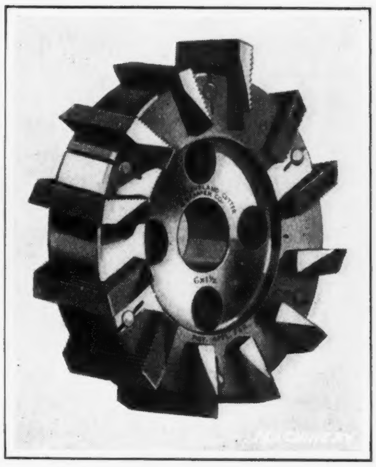


Fig. 2. Side Milling Cutter with Serrated Blades

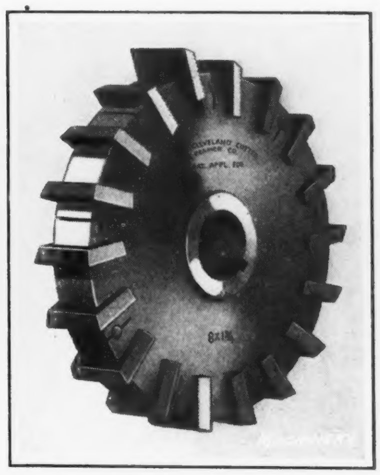


Fig. 3. Face Milling Cutter also having Serrated Blades

Fig. 3 shows an inserted-tooth face milling cutter which also has corrugated blades. These cutters have a machine-steel body, and can be furnished either with carbon or high-speed steel blades. The body of the cutter has a taper hole and a keyway for driving, the cutter being held on the arbor by a screw in the end. This same design of cutter can be made with a threaded hole for mounting directly on the machine spindle or to fit a milling machine having a flanged spindle.

ROCKWELL DIRECT-READING HARDNESS TESTING MACHINE

A portable direct-reading hardness testing machine known as the Rockwell, which is intended for hardness tests on steel, brass, copper, and some of the harder alloys is being manufactured by the Wilson-Maeulen Co., Inc., 736 E. 143rd St., New York City. The principle employed, like that in the Brinell testing method, is to apply a known load to a ball penetrator and then measure the indentation. In the Brinell method the diameter of the impression of a 3/8-inch diameter ball is measured by removing the piece to a microscope, while the Rockwell machine is designed to measure the depth of the impression of a 1/16-inch diameter ball, the measurement being shown directly on the indicator of the machine. The size of the ball permits the testing of wire of small diameter, and the light impressing load permits the testing of the outer surfaces of small tubes having a wall as thin as 1/32 inch without putting a mandrel through the tube. Thin sheet stock and such pieces as clock springs can also be satisfactorily tested.

When making a test on the machine, an initial pressure is applied by turning the handwheel, raising the test piece until the indicator shows that pressure is being applied. This insures that the test piece is held to a firm seating and that the ball breaks through dirt, scale, or other superficial matter. The indicator is then made to register zero, after which the push-button seen clearly in Fig. 2 at the base of the machine, is touched, releasing the major load. This load is later withdrawn, leaving again only the initial pressure, so that the indicator shows the depth of the impression made by the major load. The indentation is small and hardly noticeable. The machine weighs approximately 57 pounds and is furnished with several tables to accommodate various shapes of work. Generally, about six tests a minute can be made by means of the device. The greatest value of this machine for shop use is as a comparative tester.

NO. 2 STANDARD MILLING MACHINE

A hand milling machine which can be equipped with an attachment for moving the table in a horizontal direction by power has been added to the line of machines manufactured by the Standard Engineering Works, Pawtucket, R. I. The column, as shown in the accompanying illustration, is of a sufficiently rigid construction to avoid spring when heavy

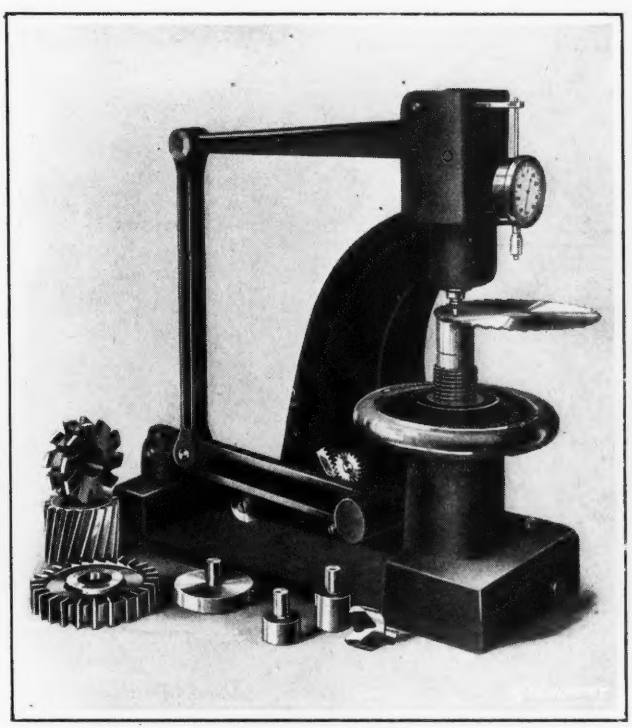


Fig. 1. Hardness Testing Machine manufactured by the Wilson-Maeulen Co.

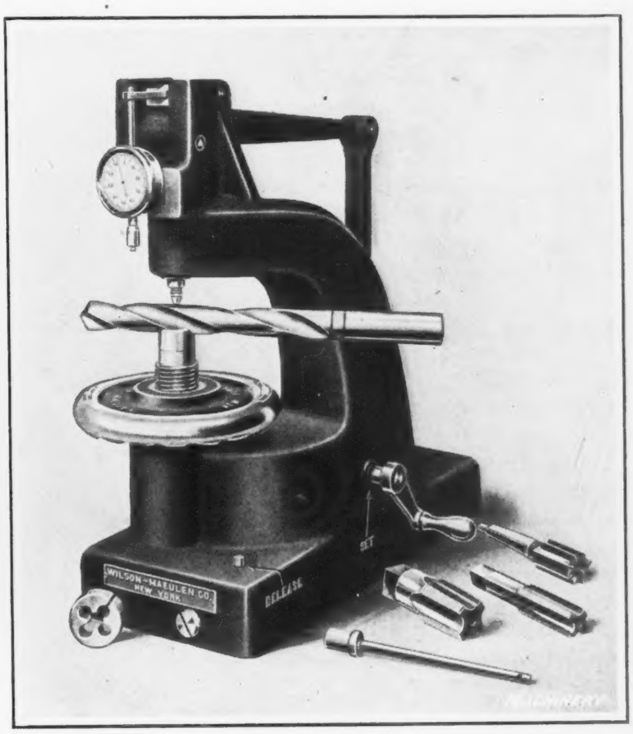
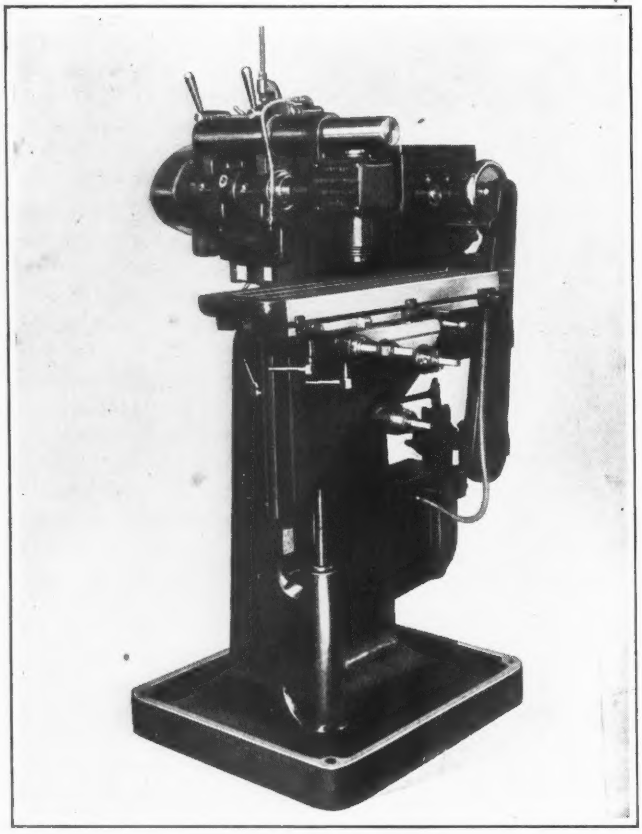


Fig. 2. Operating Side of Rockwell Hardness Testing Machine shown in Fig. 1



Milling Machine which may be fed by Hand or Power, manufactured by the Standard Engineering Works

work is being handled. The carriage is also of a heavy construction to meet the stresses likely to be imposed on it. The table is provided with three standard T-slots, and has deep oil-pockets at the ends. The headstock is gibbed to the column to permit vertical movements, but means are also provided for clamping it in any desired location. The headstock is furnished with deep oil-chambers from which the spindle is lubricated by means of felt wicks.

The spindle is made of a high-carbon steel, carefully ground and fitted, and is provided with adjustment for wear. It is supported by a phosphor-bronze bearing, and is driven by a Link-Belt silent chain which connects it to the change-gearing on the back of the machine. Twelve spindle speeds ranging from 80 to 1950 revolutions per minute are obtainable. Six of these are secured by having a 29-tooth sprocket on the spindle and a 19-tooth sprocket on the back-shaft of the change-gear box. The other speeds are obtained by placing the 29-tooth sprocket on the back-shaft and the 19-tooth sprocket on the spindle. Two levers located on the gear-box within easy reach of the operator control the various spindle speeds.

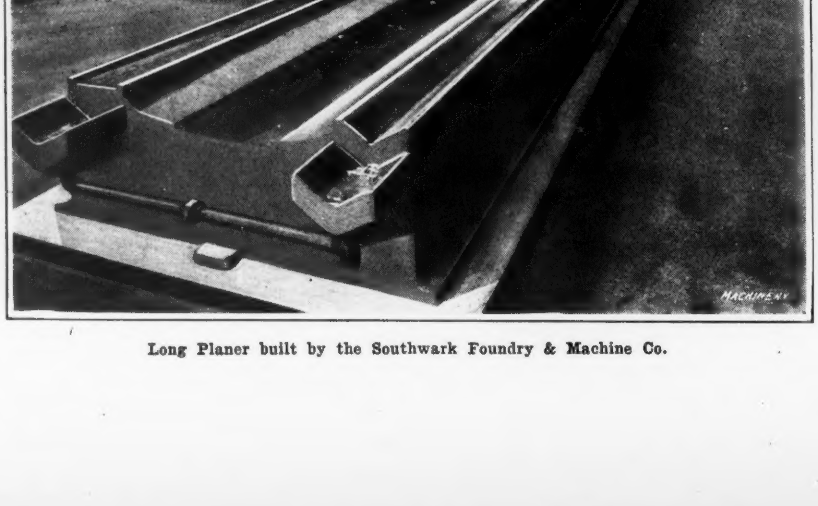
The power feed attachment for traversing the table in a longitudinal direction permits feeds ranging from 0.004 to 0.062 inch per revolution of the spindle. These feeds are obtained through a gear-box on the rear of the machine, which is located beneath the spindle change-gear box. Four feed changes can be obtained for each spindle speed by the movement of a lever easily accessible from the working position of the operator. The feed is positive, being geared from the spindle drive through a train of gears to a telescoping shaft having universal joints, which drives a worm and worm-wheel located in a rocker box. The worm-wheel is fixed on the rocker shaft which transmits power by means of a pinion to the rack on the under side of the table. An automatic and adjustable knock-off dog is located on the table. The means employed to feed the table by power and the convenient arrangement of all operating parts enable one operator to tend several machines. The machine can also be used as a hand miller without removing the power feed attachment.

A reversible geared pump with an automatic relief valve is furnished as part of the lubricating system, the relief valve permitting the stopping or regulation of the oil supply without stopping the pump or machine. The pump is driven by a small roller chain protected by a cast-iron guard. The oil tank has two compartments separated by a fine-mesh screen so that only clean oil can be drawn into the pump. When a motor drive is furnished, the machine is driven by means of a Link-Belt silent chain. This driving method can be used both on the plain and power feed machine. A one-horsepower motor running at a speed of 1200 revolutions per minute is recommended. Any of the attachments manufactured by the concern, such as a plain vertical head, universal head, and vertical spline-milling head, can be used on the machine.

SOUTHWARK PLANER

The planer shown in the accompanying illustration is one of three that the Southwark Foundry & Machine Co., Philadelphia, Pa., has recently built for the Baldwin Locomotive Works. This planer is designed for heavy-duty service on locomotive frames, and its dimensions are 7 by 3 by 42 feet. The table is made in two sections, which are joined by means of four 3-inch square key-bolts and dowels. The cross-section of the table is box shaped, and is 12 inches deep at the center and 9⅜ inches deep at the sides, with all ribs running in the transverse direction. The top flange of the table is provided with three longitudinal T-slots and 900 stop holes 1⅝ inches in diameter. The table slides upon one flat and one V-bearing, and is also guided sidewise by two vertical surfaces which resist any force that may have a tendency to push the table up the incline of the V-bearing. Both the flat and V-bearings are lubricated by a pump especially installed for this purpose.

The cross-rail is of the extended back type having a bearing of 26 by 40½ inches on the face of the uprights, as well as a 6-inch bearing on the inside of the uprights, to which it is clamped in the usual manner. As shown in the illustration, two heads are fitted to the cross-rail and two to the uprights. The bed is built up in three sections of heavy



Long Planer built by the Southwark Foundry & Machine Co.

box-section design having cross-ribs spaced 18 inches from center to center throughout the entire length of the two end sections. The middle section is also a heavy box section design having the center box between the ways left out near the middle, in which space the drive gears are mounted. All gears of the drive gearing run idle on their shafts and are bushed with phosphor-bronze bushings. The shafts are fitted to "dead eye" bearings and locked with set-screws. This arrangement makes the removal of gears a very simple matter, should it become necessary to do so in making repairs.

The planer is driven by a regular reversing type of planer motor of 75 horsepower, having a speed range of from 250 to 1000 revolutions per minute, which gives cutting speeds of from 20 to 40 feet per minute. Safety devices are provided in the control panel to take care of low voltage, no voltage, overload, and emergency stop. The master switch is operated by the usual type of table stops and dogs. A portable pendant switch is also provided for the use of the operator. The return speeds are selective, and range from 40 to 80 feet per minute.

The machine will plane work 84 inches in width, 36 inches in height, and 42 feet in length. The table is 6 feet wide and 44 feet in length. The width of face of the upright is 22 inches and its depth, from front to back, 6 feet 9 inches. The cross-rail has a face width of 26 inches; its depth at the center is 23 inches and at the uprights 8 inches. The table rack is provided with teeth of 1¾ inches circular pitch, which have a face width of 14 inches. The total weight of the machine is approximately 250,000 pounds.

CURTIS & CURTIS PIPE THREADING MACHINE

The accompanying illustrations, Figs. 1 and 2, show one of the pipe threading machines manufactured by the Curtis & Curtis Co., 324 Garden St., Bridgeport, Conn. The feature of the machine to which particular attention is called is the self-centering vise which is employed to hold the pipe during the threading operation. This vise is opened and closed by means of the large handwheel at the top of the machine frame, and will not only hold any size pipe within the capacity of the machine, but will also properly center each size with the threading die.

In Fig. 1 the vise is shown gripping a pipe of minimum size, while in Fig. 2 it is shown gripping a pipe which is nearly the maximum size for which the machine is adapted.

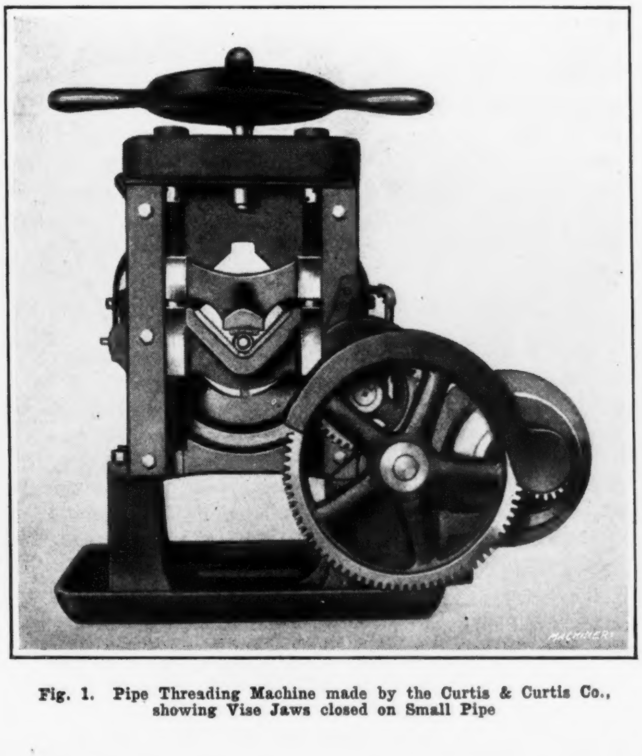


Fig. 1. Pipe Threading Machine made by the Curtis & Curtis Co., showing Vise Jaws closed on Small Pipe

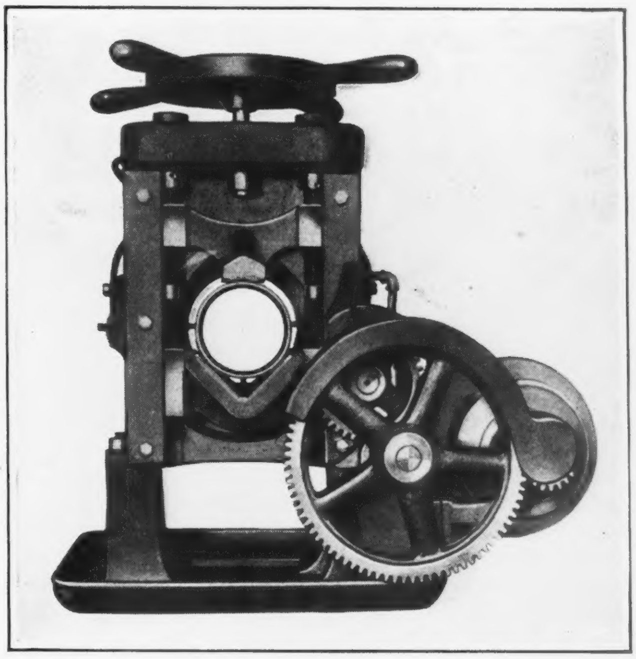


Fig. 2. Machine shown in Fig. 1, but with Vise Jaws gripping Large Pipe and still maintaining Alignment with the Threading Die

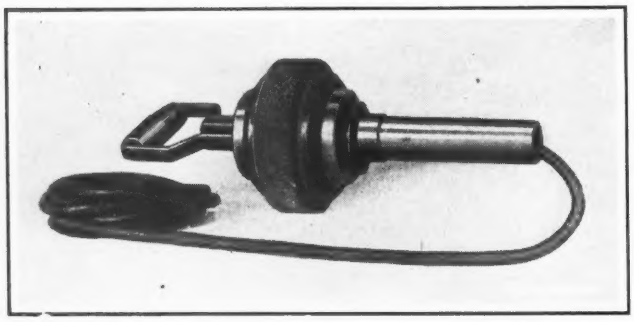
These two illustrations show clearly the exceptionally wide range of the machine. The method of obtaining the self-centering feature will be apparent from the illustrations. It will be noted that both the upper and lower jaws of the vise are actuated by two screws which pass through the ends of the members to which the serrated vise jaw plates are attached. In order to center all sizes of pipes with the die-head, it will be evident that the rate of travel of the upper jaw and the lower V-jaw must be different. This condition is obtained by cutting threads of different pitch on the upper and lower ends of the vertical screws, which will give the proper ratio between the movement or travel of the upper and lower jaws.

The pipe is put into the machine from the back, and clamped by the self-centering vise with the end to be threaded against the back of the dies. As the die-carrying gear is revolved by the pinion, the gear recedes into a shell, and the dies are brought into contact with the pipe. When the thread is cut, the dies are drawn back by a slight turn of the cam-ring and the pipe can be taken out without running back over the thread. On account of the principle of construction of this machine, which is to hold the pipe stationary and revolve the comparatively light die-head around it, pipe bends or pipes with assembled fittings attached may be threaded as easily as straight pipe. In addition, the machine is portable and requires minimum floor space.

FORBES & MYERS HAND GRINDER

The hand grinder shown in the accompanying illustration is a new product of Forbes & Myers, 178 Union St., Worcester, Mass. This grinder is intended for use in snagging castings and is especially designed to combine power with light weight. The field of the motor is mounted directly on a stationary shaft which is provided with handles at each end by which the operator can hold and control the tool. The motor is of the three-phase induction type, and the rotating part which surrounds the windings consists of a malleable iron core with copper bars welded to copper rings at each end. In order to utilize all weight to the best advantage, both the wheel flanges and the end shields are designed to carry magnetic flux, the end shields being lined with copper for this purpose.

The motor gives a maximum output of ¾ horsepower, and the weight of the grinder complete is only 20 pounds. A special insulation has been developed for the windings that cannot be burned out, even at a dull red heat, so that



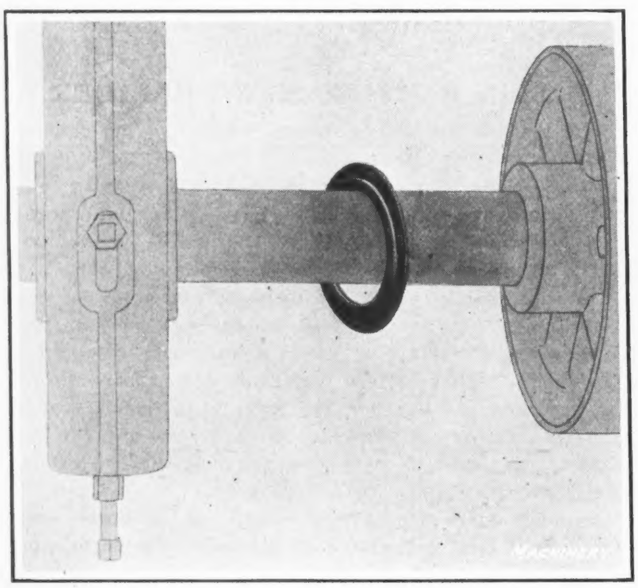
Hand Grinder made by Forbes & Myers for snagging Castings

it is practically impossible to injure the motor by overloading. The motor itself is wound for a 110-volt, three-phase circuit. For two- or three-phase circuits of higher voltage, a small transformer is provided. The switch is located in the handle of the grinder, and is so designed that a forward motion of the handle applies the current.

The grinding wheel is 7 inches by 2 inches and is mounted between a safety flange of more than ordinary taper. Tests for breakage in which a wheel was struck by a hammer and the machine was thrown against a casting failed to break out a piece of the wheel more than 1/4 inch across, which was not held by the flanges. The bearings are of copper graphite composition, and are held in an aluminum sleeve. These bearings require no lubricant and can be readily replaced when worn. Although this grinder is designed primarily for snagging castings, its power and portability adapt it for many other purposes.

AMERICAN METAL PRODUCTS SHAFT CLEANERS

A simple but effective method of keeping shafting clean is by the traversing-ring method. The ring is somewhat larger in diameter than the shaft, and it automatically travels to and fro between pulleys or bearings, the reversal being due to the change in the angular position of the ring when the leading side strikes a pulley hub or bearing at either end of its travel. As the ring is continually moving along the shaft, the latter is kept clean. These rings of the "homemade" variety are usually made of some material such as fiber or leather. The American Metal Products Co., 72 W. Adams St., Chicago, Ill., has placed on the market a metal shaft-cleaning ring which is shown herewith applied to a shaft. These rings are much cheaper than the fiber rings, and they can readily be applied or removed with the shafting in place. In fact, they are intended to be applied after the shafting is up and

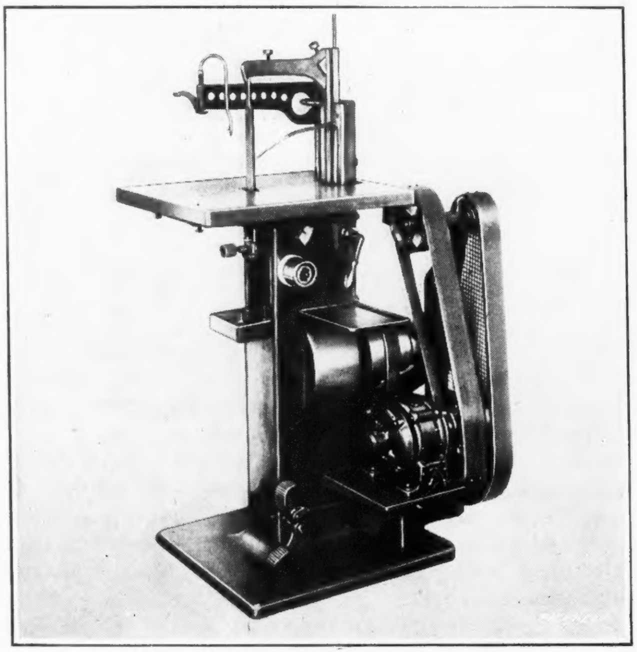


American Metal Products Co.'s Shaft-cleaning Ring applied to a Shaft

the pulleys located. The ring is made of four semicircular stampings of heavy nickel-plated sheet zinc and is non-corrosive. The joints on opposite sides are located 90 degrees apart, and the sections are locked together by four wide staples made of the same material as the rings. The ring has a circular recess which is filled with felt for gathering and distributing any drops of oil that collect on the shaft, the object being to spread the oil thinly on the shaft so that it will oxidize and scale off.

REARWIN NO. 6 DIE-FILING MACHINE

The accompanying illustration shows a No. 6 die-filing machine built by W. D. Rearwin, 716 Monroe Ave., Grand Rapids, Mich. This machine is similar in design to the No. 5 machine, but is capable of handling work of larger dimensions. It is provided with a 20- by 24-inch table, the top of which is 30 inches above the floor, and may be used in filing various other classes of work besides dies. The head is made of steel and is adapted for saws and files of lengths up to 14



No. 6 Die-filing Machine built by W. D. Rearwin

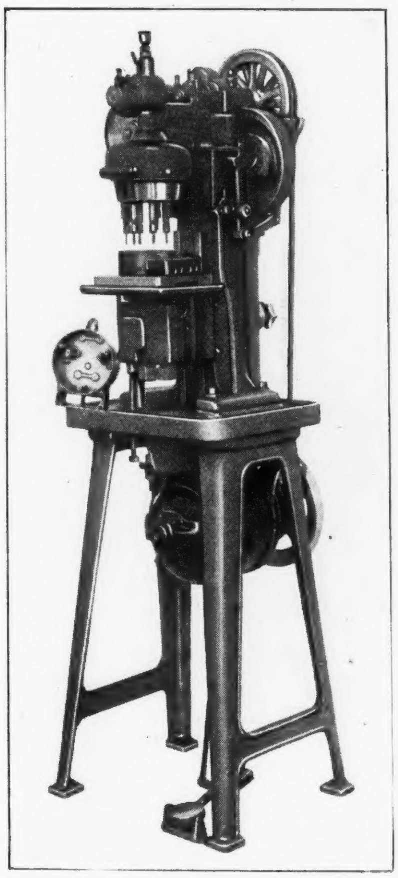
inches, having an adjustable stroke up to 7 inches. Extra arms are provided to accommodate hacksaws and to permit the special filing of parts where the under side has a shoulder or is closed. There is a distance of 9 inches between the file and the slide of the machine, and the minimum distance between the top of the table and the upper arm is 6 inches. The file is withdrawn from the work on the up stroke. The machine can be furnished with a motor or countershaft drive, or it can be driven direct from a lineshaft.

LANGELIER MULTIPLE TAPPING MACHINE

Several interesting features have been added to the semi-automatic multiple tapping machine here illustrated, which is built by the Langelier Mfg. Co., Arlington, Cranston, R. I. The machine is shown equipped for tapping eleven holes in a meter case, a completed piece being shown in an upright position on the stand on which the machine is mounted. The rate of production on this work is six cases per minute, the machine being operated by either a girl or boy. The operator sets the machine in motion by depressing a foot-treadle, located conveniently at his right, which operates the belt-shifting mechanism, moving the round leather driving belt quickly over the forward driving pulley and instantly setting in motion a horizontal shaft at the top of the machine. The

principal function of this shaft is to drive the main spindle of the multiple tapping head to which it is connected by bevel gearing.

The various spindles in the tapping head are crank-driven, machined out of solid alloy steel bars, hardened, heat-treated, carefully ground, and located with extreme accuracy on fixed centers in a phosphor-bronze spindle bearing. This bearing can be quickly removed from the machine to permit the insertion of other heads having the tapping spindles arranged to suit a different class of work, provided all the holes in the latter are within a circle 5 inches in diameter. In this way several parts can be tapped with the same machine by using different tapping heads interchangeably. The tapping spindles in each head are provided with special compensating arrangements which permit each tap to follow its own lead independently of any other tap. This feature insures that every hole will have a clean cut thread, allows the threads of different pitches to be tapped simultaneously and produces work which is uniformly accurate and interchangeable.



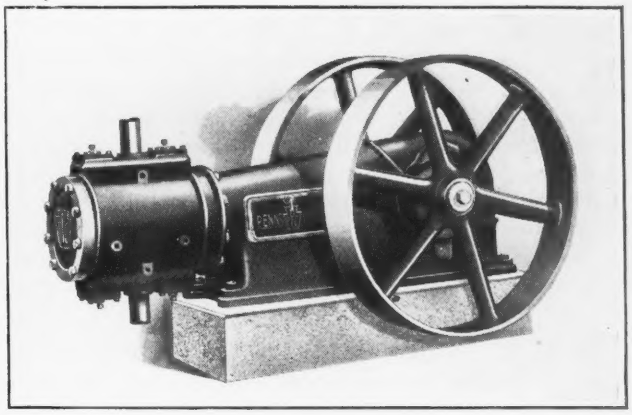
Redesigned Semi-automatic Multiple Tapping Machine, built by the Langelier Mfg. Co.

The taps are reversed automatically when the holes have been threaded to the required depth by the method described in the following. The horizontal shaft driving the tapping head spindle also drives a short horizontal shaft at the left of the machine, through spiral gearing. This shaft, in turn, drives a shifting dog gear on the back of the machine. The shifting dog gear has an edge cam over which rides a roller trunnioned to the feed rack of the work-table. During the tapping operation the work-table is progressively raised by means of this edge cam and roller until the taps have penetrated to the desired depth. An automatic trip then operates, shifting the round driving belt over on the reversing pulley. This causes the instantaneous reversal of the taps and the lowering of the table at almost twice the raising speed. When the table reaches its lowest position, the trip shifts the round driving belt to the loose pulley so that the machine is stopped.

This cycle of operations is repeated with exactness and rapidity during the tapping of each part. The automatic trip may be set to stop the table at any desired point. The upward and receding speeds of the work-table may be closely adjusted to correspond in each case with the pitch of the taps used, and the extent of the movement may be regulated to suit the thickness of the work. These provisions eliminate breakage of taps and over-traveling of the table.

PENNSYLVANIA AIR COMPRESSOR AND VACUUM PUMP

A design of air compressor now being manufactured by the Pennsylvania Pump & Compressor Co. of Easton, Pa., is shown in the illustration. This company also makes vacuum



Air Compressor made by the Pennsylvania Pump & Compressor Co.

pumps. The general design of these machines is in accordance with the modern practice of using enclosed dust-proof construction, with provision for the splash system of lubrication for the driving parts. The bored guide type of cross-head is used, which nearly fills the guide portion of the compressor frames. This head supplemented by a baffle plate placed ahead of the cross-head serves to prevent oil from the splash lubricating system entering the air cylinder.

A feature which may be mentioned in connection with the splash oil system is the provision of an oil float gage which indicates at all times the level of the oil in the basin. In the construction of the driving parts, a forged crankshaft is used which is provided with removable bronze bearings that can be quickly adjusted and easily replaced. The use of a forged crankshaft permits the employment of a solid box on each end of the connecting-rod, the eye of the connecting-rod being slipped over the crankshaft and the adjusting gibs and wedges inserted in place. The flywheels are mounted on the tapered ends of the crankshaft, being keyed and held in place by a washer and capped bolt, as shown in the illustration. A ring plate type of valve which it is said cannot cock or get out of alignment is employed. Both air compressors and vacuum pumps are of the same general construction, except that the air cylinder of the vacuum pump is of considerably greater diameter for the same stroke size, and the position of the valves is reversed. That is, while the discharge valves are at the top in the air compressor, they are placed at the bottom in the vacuum pump. These machines can be furnished in the steam-driven type with a balanced piston valve steam end, or they can be equipped for belt drive.

R. G. SMITH CUTTING-OFF TOOL

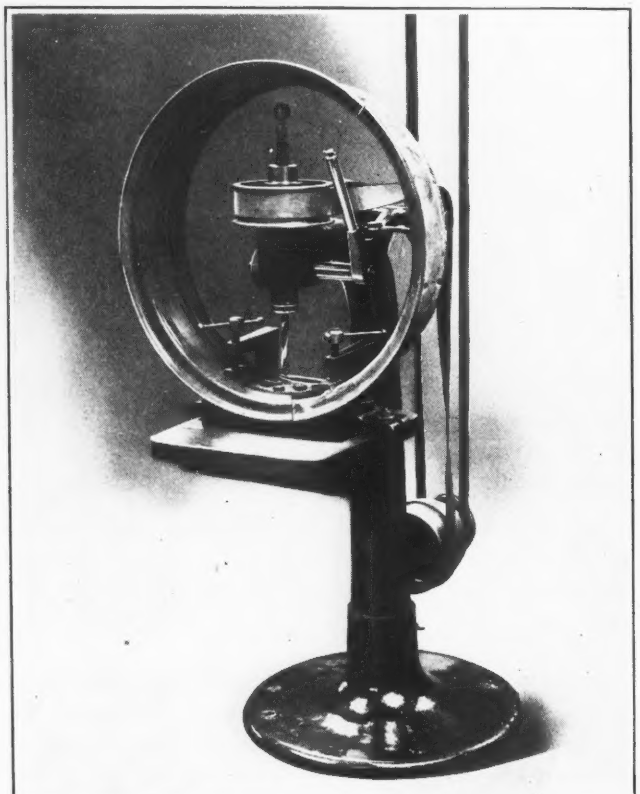
A new type of cutting-off tool having a cutting circumference extending over 300 degrees has been designed by the R. G. Smith Tool & Mfg. Co., 317 Market St., Newark, N. J., for use in connection with this company's patented tool-

Cutting-off Tool intended for Use with the Tool-holder made by the R. G. Smith Tool & Mfg. Co.

holder. This cutting-off tool is made in such a manner that sufficient clearance is maintained throughout the entire cutting circumference. The clearance is secured by gradually thinning or tapering down the thickness of the cutting edge, giving the tool ample side clearance. The manner in which the tool is secured to the holder will be apparent from the illustration, the tool being provided with a shank that extends into a hole in the holder and is clamped by means of a machine screw. The tool is particularly adapted for use on screw machines and turret and engine lathes. It is a simple matter to regrind the cutting edge as it becomes worn.

REED RIM DRILLING MACHINE

A machine adapted for drilling operations on the inside of rims of various kinds, built particularly for automobile rims, has been brought out by the Francis Reed Co., 43 Hammond St., Worcester, Mass. The machine, as shown in the accompanying illustration, is so designed that it will drill holes on the inside of rims of a minimum diameter of 20 inches and upward. The distance from the center of the drill spindle to the column is 12 inches, so that holes can be drilled in the center of a rim 24 inches wide. The machine has a capacity for driving drills up to ¾ inch diameter, and is provided with a No. 2 Morse taper in the spindle. The total vertical movement of the spindle is 5 inches, the vertical movement of the table, 3 inches. The table work-surface is 15 by 17 inches.



Rim Drilling Machine built by Francis Reed Co.

The spindle is hollow, and has a knock-out rod for removing the drills instead of the usual taper wedge arrangement. The spindle is provided with ball thrust bearings, and all oiling for the spindle bearings and driving pulley is provided for by two oil-holes at the top of the spindle mounting, which provide lubrication for all the bearings in the head. The spindle is fed by means of a reversible ratchet feed providing for convenient operation. All the pulleys are machined all over, and all the bearings are ground. A separate countershaft is furnished for the machine. The height of this machine is 50 inches, it having been made low because of the special purpose for which it was designed. The weight is 400 pounds.

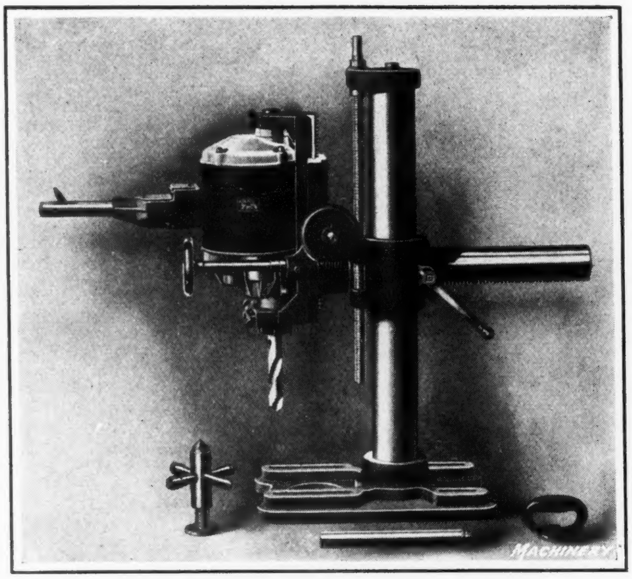


Fig. 1. Radial Drill Stand made by the Hisey-Wolf Machine Co.

HISEY-WOLF RADIAL DRILL STAND

The Hisey-Wolf Machine Co., Cincinnati, Ohio, has recently brought out a No. 3 radial drill stand designed for use with the portable electric drills of this company's manufacture. This stand has the same general dimensions and operating features as the Types NN and NNA radial drills, also made by this company. In Fig. 1 the stand is shown with a portable drill attached in position for vertical drilling operations, and Fig. 2 shows the portable drill without the stand. This stand will hold portable drills up to 1¼ inches capacity, either single- or two-speed machines. The stand greatly increases the usefulness of a portable electric drill, as it gives the user the advantages of both a radial and portable drill.

The drill-holding head may be tilted at an angle with the base, and a graduated collar facilitates setting the head at any desired angle. The method of obtaining horizontal adjustment by means of a rack and pinion, and vertical adjustment by means of a screw are apparent from the illustration. The drill has a nine-inch travel, the feed being controlled by the handwheel shown. A quick-return movement is obtained by operating a crank which can be attached to a pinion-shaft. The operating radius of the machine is 20 inches in any direction and at any angle. The handwheel and worm-box may be operated in either a horizontal or a vertical position, a feature which permits the drill to be used in corners.

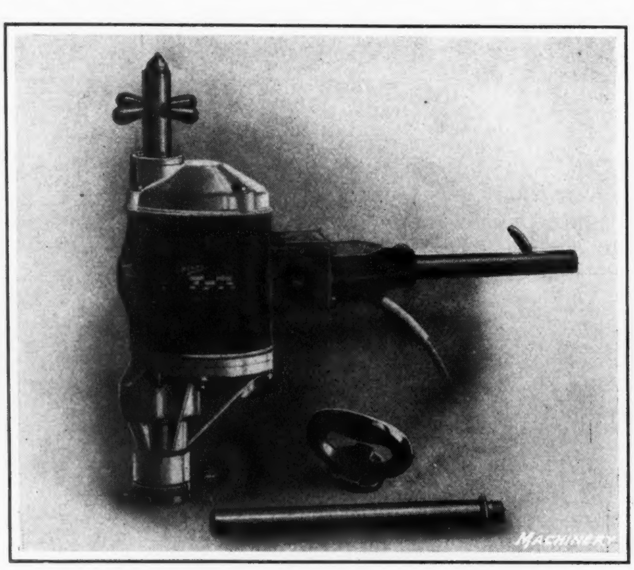


Fig. 2. Portable Electric Drill detached from Stand

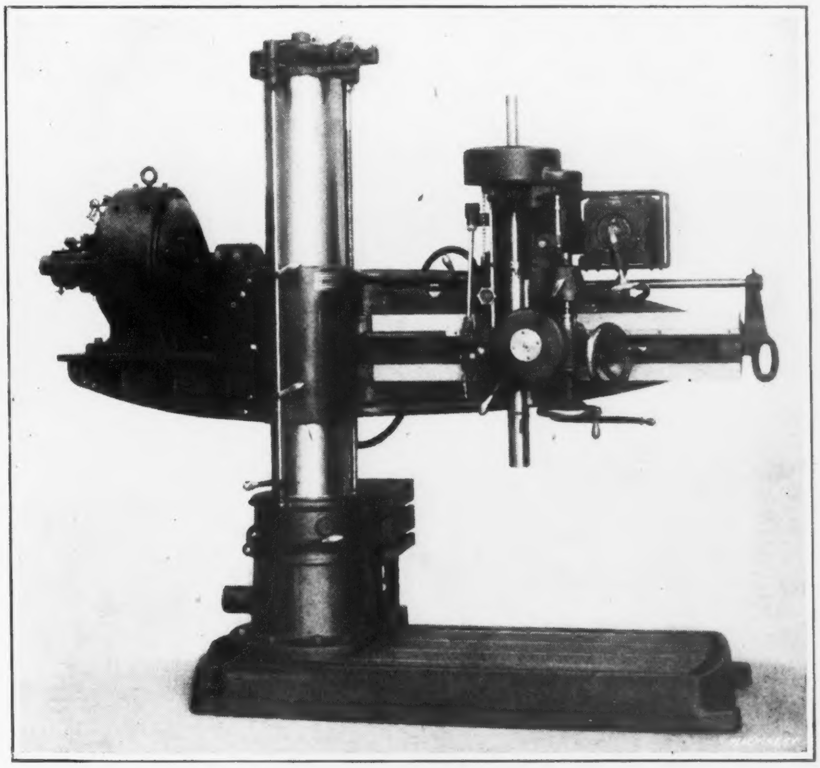
The direct-current motors are compact, and of the bi-polar type. The frames are of the enclosed type to protect the working parts from injury. The alternating-current motors are of the induction type, with laminated field and armature—the field winding being of the familiar pyramidal form, and the armatures of the familiar squirrel cage type. All motors are air-cooled by means of a fan mounted on the armature shaft.

FOSDICK RADIAL DRILLING MACHINES WITH STANDARDIZED MOTOR ON ARM

The accompanying illustration shows the 4-foot heavy-duty radial drilling machine built by the Fosdick Machine Tool Co., Cincinnati, Ohio, equipped with a five-horsepower Robbins & Myers 3-to-1 variable-speed motor on the radial arm, and a Cutler-Hammer controller directly on the spindle head. One advantage of this arrangement is the saving of power through the elimination of two sets of bevel gears. The motor is also away from dirt which accumulates about the floor, the arm is partially balanced, and additional floor space about the base of the machine is available.

The outstanding point of this particular application is the standardization feature, which means that 3-to-1 variable-speed motors of any standard make or speed may be used, thus avoiding the customary delay caused by making special patterns and castings for each particular type of motor. There is a bakelite pinion on the motor shaft, which varies in size according to the speeds of the motor as selected. All other gears are kept standard.

The fact that but one motor is used is regarded as a strong feature. The elevating mechanism drives from this motor through the regular standard gear arrangement. The controller, shown mounted on the spindle head, is made more convenient to operate by the bevel gear connection to the handwheel below it. This type of control is preferred in shops where the work is usually on large castings, the spindle head being frequently at the upper and outer extreme. A more popular location for the controller is on the arm girdle, convenient to the operator's left hand. This eliminates the large flexible conduit in the rear of the arm, and is the most satisfactory position for the average run of work. This type of motor drive is furnished on the 4-, 5- and 6-foot heavy-duty radial drilling machines.


Fosdick Radial Drilling Machine with a Standardized Motor Drive on the Arm and a Controller on the Spindle Head

NEW MACHINERY AND TOOLS NOTES

Truck Frame Riveter: Baird Pneumatic Tool Co., Kansas City, Mo. A pneumatic riveter designed especially for riveting industrial cars and truck frames, which is adapted for any steel fabrication within its range, provided the work is suspended from above. The machine is 38 inches high, weighs approximately 600 pounds, and drives and heads 3/4-inch diameter rivets, hot.

Tapping Attachments for Drilling Machines: Bessler Movable Stairway Co., 1900 E. Market St., Akron, Ohio. Automatic attachments which adapt drilling machines for the performance of tapping and countersinking operations, the attachments being placed on the cross-shaft and driving shaft of the machine. Tapping and reversing movements are automatic, and any size of tap can be used.

Straightedge or Folding Rule Attachment: Barnes & Irving, Inc., Syracuse, N. Y. A device known as the "Arrow Angler," intended primarily for attachment to a straightedge or folding rule, in order to adapt it for use as a T-square, try-square, and depth or scratch gage. It forms a quick means of laying out or finding angles, centers, diameters or tangents of circles, and of bisecting angles.

Pressed-steel Machine Handle: Rockwood Sprinkler Co., 34 Harlow St., Worcester, Mass. A hollow pressed-steel handle made by a special process which combines lightness of weight with ample strength to resist any strain to which such a part is liable to be subjected. It is suitable for the operating levers and handwheels of machine tools and similar machinery, and is made in ten sizes.

Hand Knurling Tool: A. D. Knurling Tool Co., 120 E. 128th St., New York City. A hand knurling tool which can be used on work held in a drilling machine spindle or turned by hand about work held in a vise. The work is placed between three knurls, the distance between the jaws carrying these being adjustable. By means of this device, non-circular work such as elliptical, hexagonal or square, can be knurled.

Quick-change Chuck and Collets: Charles L. Jarvis Co., Gildersleeve, Conn. A quick-change chuck and collets intended for use where different operations such as drilling, reaming, counterboring, tapping and stud setting are done with one spindle, especially when working on heavy castings with a radial drilling machine. However, it is also adapted for lathe operations. The chuck can be furnished with the type and size of taper required to fit the spindle of the machine.

Oil-burning Rivet Heater: Hoffman Products Corporation, Harrisburg, Pa. An oil-burning rivet heater in which the oil is not atomized so that the cost of motor and air compressor plants and their maintenance, is eliminated. It does not use the oil under pressure nor does it preheat the oil, thus also eliminating the possibility of carbonization. The burner is made for either vertical or horizontal installations, and temperatures up to 2500 degrees F. are obtainable in one hour.

Keyway Cutter: Velco Mfg. Co., Greenfield, Mass. A staggered-tooth cutter-bar or broach for the cutting of keyways. The bar resembles two small keyway cutters welded together, with the teeth of one advanced a distance of half the pitch. This staggered relation of the teeth allows the bar to be milled deeper, and at the same time gives it strength by making possible the machining of the cutting teeth at the root to a large radius. The cutter may be used on any broaching machine.

Induction Motor: General Electric Co., Schenectady, N. Y. A type of alternating-current motor for the operation of cranes and hoists, which was designed to take the place of the former M. T. C. and I. T. C. types. It is smaller in dia-

meter and greater in length than motors of the same horsepower of former designs, thus reducing the flywheel effect of the armature. A resister has been developed for the motor, which reduces the maximum current demand and protects the motor from abuse.

"Micro-adjustable" Boring Head: Porter-Cable Machine Co., Syracuse, N. Y. A boring head on which a cross-slide is gibbed to the body, the cross-slide being controlled by an adjusting screw, the head of which is graduated to read in thousandths of an inch. The body is provided with a ½-inch diameter shank, and the boring tools are held in a ¼-inch draw-in chuck mounted on the cross-slide. On account of the adjustability of the boring head, it is possible to utilize tools having long lips.

Self-lubricating Bearings: Reliance Machine & Specialty Co., 101 Green St., Jamaica Plain, Boston, Mass. A new oilless or self-lubricating bearing or bushing which is composed of two parts, an inner casing of bronze and an outer casing of steel tubing machined for a drive or press fit. In some instances the outer casing is made of bronze. The inner casing contains a large number of tapered holes which are filled with a lubricating mixture under pressure. These inner casings can be removed if the lubricant wears below the point of usefulness, and new ones inserted.

Manufacturing Reamer: Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. A manufacturing reamer made in three body types — shell, straight shank, and taper shank — in which any of the following blades are interchangeable: Right-hand spiral for fast reaming in steel; left-hand spiral for fine finish in steel, aluminum, and bronze; and straight blades for cast-iron work. The reamer is especially suited for machining large quantities of duplicate work. It can be readily adjusted in the tool-room, but is so constructed that the machine operator is not likely to attempt readjustments.

Tire-turning Lathe: Putnam Machine Co., Fitchburg, Mass. A heavy 54-inch tire-turning lathe for car, tender and engine truck wheels, which has a bed 23 feet long, and weighs 86,000 pounds. The tool-slide arrangement reduces the turning of a pair of tires to two operations, both of which are performed without changing the cutting tools. The tailstock is moved along the bed by power. Each faceplate is equipped with four non-slip driving dogs and the maximum distance between the faceplates is 10 feet 9⅞ inches. A calibrating attachment is furnished, which remains on the machine, and, when specified, the machine can be equipped with a pneumatic crane to facilitate the mounting of work.

Heavy-duty Horizontal Boring Machine: Rockford Drilling Machine Co., Rockford, Ill. A heavy-duty horizontal drilling and boring machine adapted for various classes of automobile work such as boring cylinders, crankcases and transmission cases for tractors, trucks, and passenger cars. It is also suitable for performing facing, counterboring, drilling and reaming operations. The head of the vertical heavy-duty drilling machine made by this concern, complete with driving gear, spindle and feed mechanism, is used. The spindle travel ranges from 12 to 40 inches. Two work-holding fixtures mounted on an indexing table are provided so that while one fixture is being unloaded and loaded, the piece in the other is being machined.

Surface Grinding Machine: Wilmarth & Morman Co., 1180 Monroe Ave., N. W., Grand Rapids, Mich. A No. 78 surface grinding machine developed to meet the exacting requirements of precision tool and gage grinding. Particular attention was given during its design to the location of all operating controls, so that it is unnecessary for the attendant to leave his working position to adjust the wheel-head, to change the amount of cross-feed, or to dress the grinding wheel with the built-in wheel truing device. The table has a working surface of 6 by 22 inches and three T-slots which allow the clamping of long work or the use of a magnetic chuck. The longitudinal and transverse movements of the table are automatic in both directions. Vertical adjustment of the wheel-head is accomplished by means of two elevating screws. This machine is regularly furnished for wet grinding.

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Three engineering firms in England have formed an organization known as the United British Manufacturers, Ltd., for the purpose of trading with Russia. The following are the associated companies and their products: Spear & Jackson, Sheffield, steels, saws, files and small tools; John Pickles & Son, Hebden Bridge, woodworking machinery, etc.; B. R. Rowland & Co., Ltd., Reddish, Stockport, grinding machinery and abrasive wheels.

PERSONALS

C. R. Weber has been elected treasurer of the Sherritt & Stoer Co., Inc., Philadelphia, Pa., to fill the vacancy made by the retirement of C. H. Stoer. Mr. Weber had previously been in charge of the accounting department.

Frank Conrad, consulting engineer of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been appointed assistant chief engineer. Mr. Conrad has been connected with this company for almost thirty years.

Edward S. Jenison has been made acting general sales manager of the Goulds Mfg. Co., Seneca Falls, N. Y., manufacturer of Goulds pumps, to succeed W. E. Dickey, who is retiring from business. Mr. Jenison has been manager of the Philadelphia branch for the last five years.

Hugh R. Corse who, for the last six years, has been general sales manager of the Titanium Bronze Co. is now connected with the Lumen Bearing Co., Buffalo, N. Y., in the capacity of sales engineer. Mr. Corse has a large acquaintance with the executives and engineers of the automotive industries as well as with the machine tool industry.

A. A. Rackoff, Wilkinsburg, Pa., announces that he is now engaged in private practice for the designing, developing, estimating, and supervising of the latest method of purifying liquid steel for various grades in open-hearth plants. Mr. Rackoff also specializes in a new type of reversing gears for coke oven batteries for all movable parts at the oven.

Hugh A. Brown has been appointed sales manager of the Electro Dynamic Co., Bayonne, N. J. He will have his office at the Bayonne works, and will have entire charge of the marketing of the company's products, which include alternating- and direct-current motors and direct-current generators. Mr. Brown has previously been connected with the Crocker-Wheeler Co. and the Burke Electric Co.

William Printz has been placed in charge of the New York territory for the Wilson-Maeulen Co., 736 E. 143rd St., New York City, manufacturer of pyrometers. Mr. Printz has been actively associated with the sale and installation of pyrometers throughout the Middle West for the last five years. His headquarters will be at the main office and the works of the company at 383 Concord Ave., New York City.

H. L. Dean, has resigned as manager of the compressor and engine sales division of the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City. To fill the vacancy thus formed, J. F. Huvane has been appointed eastern manager of compressor and engine sales, with headquarters at 6 E. 44th St., New York City, and G. C. VandenBoom has been appointed western manager, with headquarters at 300 N. Michigan Blvd., Chicago, Ill.

R. F. Eissler has been appointed assistant to the vice-president of the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City. W. C. Straub, formerly district manager of the New Orleans branch, has been appointed district manager of the Pittsburg branch to succeed Mr. Eissler. Ross Wyeth, who was formerly connected with the Pittsburg branch, has been appointed district manager of the New Orleans branch to succeed Mr. Straub.

* * *

THE AMERICAN RAILWAY ASSOCIATION OPPOSES THE METRIC SYSTEM

The American Railway Association, which includes almost all the railroads in the country, representing in its mileage a total of 310,000 miles—practically the total mileage of the United States—at a meeting of the Engineering Division of the association in 1920 in Chicago passed resolutions in opposition to the use of the metric system. The Mechanical Division of the association passed similar resolutions at a meeting held in Atlantic City. Under date of November 24, 1920, a communication was received by the American Institute of Weights and Measures, 115 Broadway, New York City, from J. E. Fairbanks, general secretary and treasurer of the association, from which the following is quoted: "On the recommendation of the executive committee, the American Railway Association, at its session on the 17th of November, 1920, adopted the following resolution:

'Resolved: That the American Railway Association hereby ratify the action taken by the Engineering and Mechanical Divisions in opposition to the adoption of the metric system of weights and measures to the exclusion of the English or American system at present in general use, and express its hearty approval of the effort which is now being conducted to combat the propaganda being waged throughout the country urging the enactment of legislation whereby the metric system would be made the sole standard of weight and measure.' "

VONNEGUT MACHINERY CO.'S NEW BUILDING

The Vonnegut Machinery Co., Indianapolis, Ind., has moved into its new home at 19-29 W. South St. The building is of reinforced concrete, fireproof construction, 95 by 300 feet, with two stories and basement of heavy construction, permitting of adding several stories later. The building has been carefully planned for efficient service. The first floor has a ceiling height of 18½ feet; a 10-ton crane runs the entire length of the building to facilitate the handling of heavy tools, and ample trucking facilities have been provided for by a 40- by 60-foot driveway, each end of which has a loading platform 20 by 20 feet, level with the truck. Elevators are provided at each of these loading platforms, one being of 5-ton and the other of 2½-ton capacity. The floors are constructed to take a live load of 300 pounds per square foot, and a dead weight of approximately 1000 pounds per square foot. The shipping department is provided with 5-ton dial scales built into the floor.

The entire front of the main floor will be devoted to the display of heavy machinery. Behind this there is a department for small tools and grinding wheels, with an individual office and an individual sales force. The power transmission stock is displayed in especially designed racks and bins, and the used machinery department, including a machine shop for rebuilding old machine tools, is at the rear of the main floor. Surplus or storage stocks are carried in the basement. One section of the main floor is devoted to executive and sales offices, while the general offices are located on the balcony floor immediately above.

OBITUARIES

E. C. Parshall, general manager of the Bay City Forge Co., Erie, Pa., died January 11.

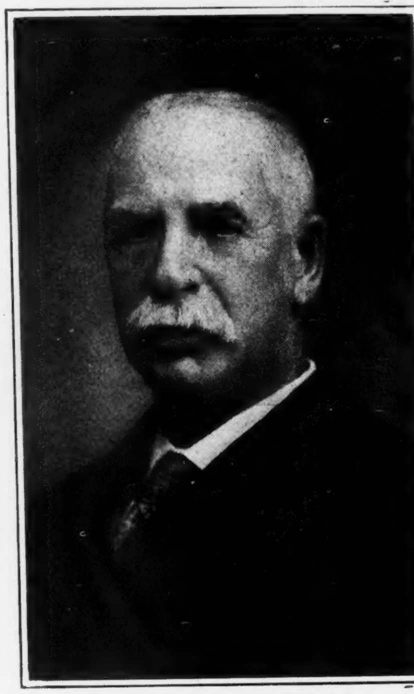
Charles H. Armstrong, secretary and treasurer of the Armstrong Mfg. Co., Bridgeport, Conn., died January 1.

Alfred G. Ely, president of the Tremont Mfg. Co. of Boston, Mass., manufacturer of wrenches, died suddenly January 20, at his residence, the Murray Hill Hotel, New York City, at the age of seventy-four. Mr. Ely had not been active in business for several years.

Folke W. Weston, master mechanic of the F. Wesel Mfg. Co. of Brooklyn, N. Y., died suddenly on December 20, aged forty-four years. Mr. Weston came to this country from Sweden about twenty-seven years ago. He early showed an aptitude for things mechanical, and as master mechanic of the F. Wesel Mfg. Co. was very active in the development of machinery produced by this company, which includes machines for printers, electrotypers, stereotypers and photo-engravers. He had several patents to his credit. Mr. Weston was of pleasing personality, and had the ready cooperation of the men under his direct charge. He is survived by a widow and three children.

ELMER A. BEAMAN

Elmer A. Beaman, treasurer and general manager of the Beaman & Smith Co., Providence, R. I., died January 4 at his home in Providence. Mr. Beaman was born in Worcester, Mass., September 2, 1846. Part of his early life was spent in the West, where his family moved when he was about seven years old. Here he attended school in a log schoolhouse three months in the winters, and as soon as he was old enough, he worked on a farm during the summers.



Later Mr. Beaman's family returned to the East. In the winter of 1862 he enlisted in the Twenty-third Regiment, New York State National Guard and served in the Civil War, taking part in the battle of Gettysburg. He was discharged from the service in 1863, when he went to Worcester to learn the machinist's trade. In 1864 he again enlisted, this time in the Forty-second Regiment, Massachusetts Volunteer Militia, and remained in the service until the end of the war. He then returned to Worcester and finished his apprenticeship, studying evenings to improve his education.

In 1866 he came to Providence, and has since lived in that city. He was there associated with the Star Tool Co., of which concern he served as treasurer. He was also for many years a salesman for the Brown & Sharpe Mfg. Co., which he left in 1886 to found the Beaman & Smith Co. with George H. Smith, who at that time was chief draftsman for the Brown & Sharpe Mfg. Co. Mr. Beaman acted as treasurer and general manager of the Beaman & Smith Co. until obliged to resign on account of ill health last October.

Mr. Beaman was a member of the American Society of Mechanical Engineers and the Providence Chamber of Commerce, and was a past-president of the Providence Branch of the National Metal Trades Association. He is survived by his wife, one daughter, and two sons, one of whom, L. E. Beaman, is now treasurer of the Beaman & Smith Co.

COMING EVENTS

February 8-12—Convention of the Pressed Metal Association in Youngstown, Ohio. Headquarters of the association, Illuminating Bldg., Cleveland, Ohio.

April 27-29—Convention of the Society of Industrial Engineers in Milwaukee, Wis. Business Manager, George C. Dent, 327 S. La Salle St., Chicago, Ill.

May 4-7—Eighth convention of the National Foreign Trade Council in Cleveland, Ohio. Secretary, O. K. Davis, 1 Hanover Square, New York City.

May 16-18—Joint convention of the National Supply & Machinery Dealers' Association, the Southern Supply & Machinery Dealers' Association, and the American Supply & Machinery Manufacturers' Association in Atlantic City, N. J.; headquarters, Marlborough-Blenheim Hotel.

May 19-20—Spring convention of the National Machine Tool Builders' Association in Atlantic City, N. J.; headquarters, Hotel Traymore. General manager, Charles E. Hildreth, Worcester, Mass.

The February sectional meetings of the American Society of Mechanical Engineers are as follows: **February 7**—Hartford section at the City Club, Hartford, Conn.; **February 8**—Boston section at the Engineers' Club, Boston, Mass.; **February 10**—Utica section in the Auditorium of the Utica Gas & Electric Co., 406 Lafayette St., Utica, N. Y.; **February 11**—Columbus section at the Southern Hotel, Columbus, Ohio; **February 18**—Detroit section in the Auditorium of the Board of Commerce, Detroit, Mich.; **February 18**—Toledo section in the Auditorium of the Railway & Light Co., Toledo, Ohio; **February 23**—Atlanta section in the Carnegie Library, Atlanta, Ga.; **February 28**—Philadelphia section at the Engineers' Club, Philadelphia, Pa.

SOCIETIES, SCHOOLS AND COLLEGES

Division of Engineering of the National Research Council, 29 W. 39th St., New York City. Booklet outlining the purpose and work of the National Research Council and the Division of Engineering.

Lowell Textile School, Moody St. and Colonial Ave., Lowell, Mass. Quarterly bulletin for November, 1920, containing an article entitled "Organic Research," relating to work done in the Organic Laboratory of the school.

NEW BOOKS AND PAMPHLETS

Use of Ammonium Persulphate for Revealing the Macrostructure of Iron and Steel. By Henry S. Rawdon. 9 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 402 of the Bureau of Standards. Price, 5 cents.

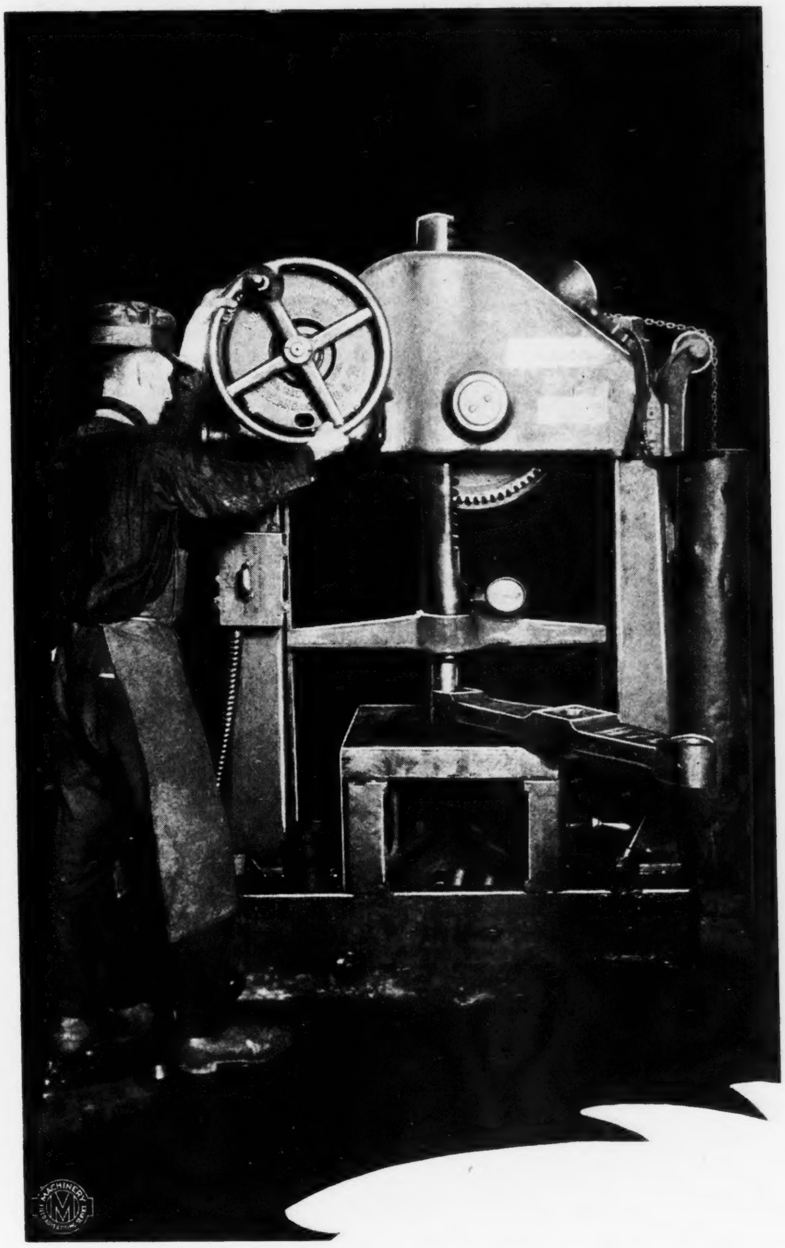
Tests of Bond Resistance between Concrete and Steel. By W. A. Slater, F. E. Richart, and G. G. Scofield. 66 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 173 of the Bureau of Standards. Price, 25 cents.

Employment Methods. By Nathan W. Shefferman. 573 pages, 6 by 9 inches. Published by the Ronald Press Co., 20 Vesey St., New York City. Price, $5.

The author of this book was formerly personnel director for the Lycoming Foundry & Machine Co., the Baltimore Copper Smelting & Rolling Co., and the C. F. Sauer Co., and his wide experience has therefore given him an opportunity to present the subject dealt with in a very comprehensive manner. The book is divided into thirty-one chapters, each dealing with some specific phase of the subject, the material covering in general the functions and developments of an employment department, methods of hiring employes, and methods of retaining employes; there is also a special section on the human element. Office employes are dealt with in a separate section, and every phase of the subject is quite completely covered. The book is well illustrated by forms used for different purposes in connection with employment management, and should be of interest to employers in general, and particularly to those who are engaged in employment management and in the hiring and discharging of industrial workers.

Practical Mathematics for Toolmakers, Draftsmen, and Machinists. By John M. Christman. 169 pages, 5½ by 8 inches; 500 illustrations. Published by John M. Christman, 215 Rhode Island Ave., Detroit, Mich. Price, $2.75.

This book is intended for toolmakers, draftsmen, and machinists who wish to study mathematics without the aid of a teacher. The appearance of the book is unique, as it is not printed from type but from plates made from typewritten copy. The problems presented have been accumulated for the last ten years from various tool-rooms and drafting-rooms. The contents are as follows: Fractions; Decimal Fractions; Proof of Multiplication and Division; Percentage; Formulas and Grouping Symbols; Gear and Lead-screw; Ratio and Proportion; Graduated Dials; Square Root; Pythagorean Theorem; Vernier Instruments; Cutting Speeds and Feeds; Geometry and Mensuration; Areas and Volumes; Angle Problems; Similar Figures; Taper Problems; Trigonometry; Sine Bar; Gage Problems; Checking Holes Bored at an Angle; Spur Gear; Bevel Gear; Worm-gear; Dividing Head; Continued Fractions and Convergents; Gearing of the Lathe; Gearing of the Mill; Backing off Spiral Fluted Hobs; Spiral Gear Cutting; Special Sine Bar for Tapers; Solutions and Answers; Trigonometry Table; and Factor Table.



A LUCAS

Power Forcing Press At Work in the D L & W's Scranton Shop

There are two of these simple and effective machines in this busy railroad shop—one a 30-ton press, the other with 50 tons capacity. The oldest has been in use for five years and both are giving excellent satisfaction.

The operation shown is forcing a bushing 4″ long by $2\frac{1}{2}$″ diameter into a locomotive hanger forging to be used in brake rigging, and is readily accomplished with 3 to 4 tons of pressure.

The sphere of the Lucas Power Forcing Press covers that big tract of "no man's land" where the hand or screw press is too small and the hydraulic too large to work to advantage.

Control and adjustments center in the wheel, which automatically applies power when the ram meets with the resistance of the work. Action is rapid and positive.

Power is obtained from a worm wheel on the pulley shaft through a friction clutch and is transmitted to the ram by means of gearing controlled by the hand wheel.

No valves to leak—no pipes to freeze—no packing to renew. "A good all round tool" is the verdict on this machine wherever it is installed, whether for bending, straightening, forcing, marking, forming or broaching and new uses develop for it every day.

Illustrated Circular tells the whole story.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Aux Forges de Vulcain, Paris. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

Straight Business in South America. By James H. Collins. 305 pages, 5 by 8 inches. Published by D. Appleton & Co., 35 W. 32nd St., New York City. Price, $2.50, net.

This book presents observations made by the author during an eight months' trip to South America, and consequently contains first-hand information on business conditions in the countries visited. It deals with the getting, building, and handling of business with South America. The material has been drawn entirely from five South American countries, namely, Argentina, Brazil, Chile, Uruguay, and Peru. An idea of the treatment of the subject will be gained from a list of the chapter headings, which are as follows: Wanted—Business Imagination for Export; What South America is Like; What the People and the Countries are Like; The Tools of the Trade: Our Own Banks—Our Own Ships—Investments—Distribution — American Retailing — American Consumer Advertising; Doing Business with South America; Why South America Needs Continental Methods; The Other Fellow—Our Competitor; What do South Americans Think about Yankees?; The Importance of Buying as well as Selling; About "Picking up" the Spanish Language; What Chance for Me in South America; What You will Need in South America; The South American Farmer; Who was Who in South America—Paragraphs of History; and the Canal Zone—A Sample of Us.

Mechanical World Year Book for 1921. 318 pages, 4 by 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 2s. 6d., net.

This is the thirty-fourth edition of a well-known pocket book for mechanical engineers. The present edition contains a classified buyers' directory published in French, Russian, and Spanish, in addition to the material in the year book proper. Among the subjects covered in the present year book are: steam engines; steam turbines; steam boilers; gas engines; oil engines; Diesel engines; suction gas producers; properties of metals and alloys; structural iron and steel work; toothed gearing; grinding; limit gages; ball and roller bearings; belting; rope driving; friction and lubrication; water and hydraulic work; steam heating; heating and evaporating liquids; shrinkage of castings; screw-cutting tables; weights of bolts and nuts; dimensions of steam pipe fittings; weights of bar iron and steel angle; metric conversion tables; areas of circumference of circles; tables of squares, cubes, and roots; tables of logarithms and trigonometrical ratios. The sections on cast-tooth gearing and on ball and roller bearings are new features of the present edition. The matter on chain gearing has been rewritten and extended, and a new table has been introduced on the properties of saturated steam. Other revisions have been made and new illustrations incorporated.

The Electric Furnace. By Henri Moissan. Translated by Victor Lenher. 313 pages, 6 by 9 inches; 42 illustrations. Published by the Chemical Publishing Co., Easton, Pa. Price, $3.50.

This is the second edition of a work originally written in French, which contains the results of chemical researches with the electric furnace made by Henri Moissan. It is of interest primarily to metallurgists, the material being confined entirely to research work rather than to the industrial application of the electric furnace. The book is divided into four chapters. In the first are described different forms of laboratory electric furnaces, and their application to a study of the fusion and volatilization of a number of refractory bodies. The second chapter contains a study of the three varieties of carbon—amorphous carbon, graphite, and diamond. The third chapter describes the preparation by means of the electric furnace of a number of elements. In it is described the work done with the electric furnace on chromium, manganese, molybdenum, tungsten, uranium, vanadium, zirconium, titanium, silicon, and aluminum. The forth chapter contains the results of research carried out on a new series of binary compounds—the carbides, silicides, borides, phosphides, arsenides, and sulphides. It deals with the discovery of new compounds, their preparation, properties, and analyses. The preparation of calcium carbide has been the subject of new investigation which is gone into in detail. General conclusions complete the work.

Factory Organization and Administration. By Hugo Diemer. 398 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $4.

This book is now in its third edition, modifications having been made in the original text in order to conform to the evolution of management and standards of present-day practice. The changes that have been made are in the chapters relating to general organization, the personnel department (including employment and industrial relations), and functional control of production. The book treats of practice in both organization and administration. It discusses the details of the subject from factory location and building through department organization and relation to costs and wage systems. The material is divided into twenty-eight chapters, headed as follows: The Principles, Field, and Methods of Industrial Management; Industrial Finance; Organization and Control; Typical Factory Organizations; Factory Accounts; Departmental Reports; Factory Location; the Planning of Factory Buildings, and the Influence of Design on their Productive Capacity; Personnel Department; Office Management; the Order Department; Bills of Material; the Drafting Department; the Pattern Department; the Purchasing Department; Stores and Stock Department; Planning and Supervising Production; Foundry Systems; the Machine Shop and Tool Department; Shipping and Receiving Departments; Time Taking; Cost Department; Aids in Taking Inventory; Inspection Methods in Modern Machine Shops; Rate Fixing and Time Studies; Wage Systems; Principles Underlying Good Management; and a Bibliography of Works Management.

Financial Engineering. By O. B. Goldman. 271 pages, 5½ by 8½ inches. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $3.50, net.

This book is written as a text for consulting, managing and designing engineers and students. The author calls attention in the preface to the fact that an engineer, besides needing to be familiar with the properties of materials, the action, limitations, and application of machines and instruments, must be able to translate engineering factors into dollars and cents. This work gives rules by which the engineer may determine the value, economically, of the different types and installations of machinery. It gives a basis for rate-fixing by translating units of time and power into dollars. Methods are outlined for determining the financial efficiency of a system when the mechanical efficiency is known. The book should be useful in organizing new plants or systems where economy is effected by choosing units of proper size. It is written primarily for the practicing engineer. All mathematical deductions are worked out in detail. Many examples are also fully worked out to illustrate the practical applications of the technique. The contents are as follows: Cost Segregation; Fundamental Financial Calculations; Basic Costs; Vestances; Unit Cost Determination; Determination of Size of System for Best Financial Efficiency; and Determination of Type and Size of Units. In the second chapter on cost segregation, among the important points discussed are interest and rents, depreciation and appreciation, materials consumed, maintenance, stock account, and storage, sale, and distribution. The chapter on basic costs considers the prices and operating costs of steam engines, oil engines, motors and generators, boilers, etc., and also gives prices of standard wrought-iron pipe, wood pipe, and riveted steel pipe.

NEW CATALOGUES AND CIRCULARS

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Sheets for loose-leaf catalogue, containing dimensions and prices of electric controlling apparatus for December, 1920.

Bickett Machine & Mfg. Co., Cincinnati, Ohio. Leaflets illustrating and describing Bickett heavy-duty 28- by 28-inch by 6-foot metal planer, and 36- by 36-inch by 12-foot metal planer.

Stever-Beagle Mfg. Co., 214 Temple St., Syracuse, N. Y. Circular describing and illustrating the application of the Beagle ball lubricator for lubricating shafts or spindles in motion.

Walworth Mfg. Co., Boston, Mass. Circular showing the different styles and sizes of brass gate valves, brass globe and angle valves, and brass check valves made by this company.

Metal Saw & Machine Co., Inc., Springfield, Mass. Circular descriptive of the Napier horizontal multiple stock holder for use in connection with the Napier horizontal metal-cutting machine.

Allegheny Gear Works, Pittsburg, Pa. Publication entitled "Gear Teeth," containing material of interest to gear users, relating to Allegheny gears as well as to the gear industry in general.

National X-Ray Reflector Co., Chicago, Ill. Calendar for 1921, showing on each sheet lighting fixtures and equipment suitable for illuminating factories, offices, show windows, show cases, etc.

Uehling Instrument Co., 71 Broadway, New York City. Bulletin 111, describing the construction and principle of operation of the Uehling carbon dioxide recording equipment for use in boiler plants.

W. M. & C. F. Tucker, Hartford, Conn. Catalogue 2, containing illustrations, descriptive material, and specifications for Hercules shears and rod cutters, which are made in six sizes for cutting flat sheets and bar iron.

Ross Heater & Mfg. Co., Inc., Buffalo, N. Y. Catalogue F, descriptive of the Ross closed or tubular type heater for heating fluids. The catalogue also describes condensers, expansion joints, coolers, and airjector pumps manufactured by this company.

General Electric Co., Rock Drill Department, Fort Wayne, Ind. Bulletin 48902, illustrating and describing in detail the Fort Wayne Type A electric rock drill for use in mines, tunnels, quarries, and other places where rapid advancement of the work is demanded at low drilling cost.

Wright Mfg. Co., Lisbon, Ohio. Catalogue descriptive of high-speed hoists, screws, differential blocks, and steel trolleys. A section of the catalogue is devoted to a discussion of the various types of hoists and the field of usefulness of each. Copies will be furnished upon request.

Holz & Co., Inc., 17 Madison Ave., New York City. Bulletin 41, containing a history of magnetic analysis in the United States, as well as a detailed description of the Burrows defectoscope and magnetic analyzer for inspecting steel rails, rods, wire cable, and all other steel and iron stock of uniform section.

Bristol Co., Waterbury, Conn. Bulletin 303, covering the Bristol line of recording, indicating and controlling instruments, which includes pressure and vacuum gages, liquid level gages, thermometers, pyrometers, voltmeters, ammeters, wattmeters, mechanical and electrical time recorders, temperature controllers, etc.

Diamond Machine Co., Providence, R. I. Bulletin entitled "The Diamond on the Job," describing and illustrating a number of different jobs successfully performed on Diamond heavy-duty face grinding machines. The bulletin, which covers 48 pages, includes on every page a description of some specific job together with one or more halftone illustrations.

Cowan Truck Co., 16 Water St., Holyoke, Mass. Catalogue entitled "Transveyor Picture Book," containing seventy views of installations of the Cowan transveyor in machine shops, automobile factories, printing plants, freight terminals, textile factories, rubber factories, foundries, and numerous other industries. A diagrammatic view of the Type G all-steel transveyor is shown, on which is indicated the distinctive features.

National Tube Co., Pittsburg, Pa., Bulletin 14C, treating of the characteristics and advantages of National tubular steel poles, and discussing the types of service for which they are especially fitted, which include trolley lines, telegraph or telephone lines, transmission lines, street lighting, signal or semaphore poles, flag poles, etc. The bulletin also contains tables of dimensions, capacity, etc., for steel poles, and properties of pipe.

Alvord Reamer & Tool Co., Millersburg, Pa. Catalogue 5, containing illustrations and tables of dimensions and prices of the line of reamers, drills, milling cutters, structural workers' tools, special tools, and drop-forgings made by this company. Catalogue 5-A, containing specifications relating to tools for automobile repair work. These catalogues also contain tabular matter covering tables of decimal equivalents, tap drill sizes, etc.

Smalley-General Co., Inc., Bay City, Mich. Circular (Series A) containing time studies for performing various thread-milling operations on sixteen different parts, giving the equipment, dimensions of work being operated on, material, and time consumed. Leaflet illustrating and describing the Smalley-General No. 23 hollow-spindle thread and form miller, which has a swing of 20 inches, and a normal milling capacity of 13 inches outside diameter and 17 inches inside diameter.

Tate-Jones & Co., Inc., Pittsburg, Pa., is issuing a monthly publication entitled "Metal Heating," devoted to the interests of heat-treaters and forgers. It contains articles on carburizing, case-hardening, and the heat-treatment, in general, of various classes of metals for different uses, and shows heat-treating furnaces and other equipment made by Tate-Jones & Co. for this purpose. The journal is offered without cost to all who are interested in the heat-treatment of metals.

Hanna Engineering Works, 1765 Elston Ave., Chicago, Ill. Catalogue 4, illustrating and describing Hanna pneumatic riveters. The book describes in detail the construction and operation of this type of machine, including an explanation of the Hanna motion for actuating the dies, which is an exclusive feature of this machine. The different sizes and styles of machines are illustrated, and a large number of views show their application to boiler, tank, structural, bridge, car, automotive, and steel shipbuilding work.

Norton Co., Worcester, Mass. Catalogue treating of balancing equipment for grinding wheels, containing general information on the balancing of grinding wheels, as well as an outline of the several methods of putting a wheel in balance. The Norton line of balancing equipment is illustrated, including balancing ways, bushings and spiders, balancing centers, balancing bands, and balancing flanges. Special directions are given for balancing offhand wheels, 5-inch hole wheels, and wheels with 12-inch and larger holes.

Bausch & Lomb Optical Co., Rochester, N. Y. Catalogue of projection apparatus, including a new model balopticon for lantern slides, a new model for the production of large opaque objects, and improved apparatus for microscopical projection. The first part of the catalogue contains a discussion of optical projection and its various applications, and gives specifications for equipment for this purpose. The remainder of the catalogue is devoted to balopticon accessories, including lenses, spectroscope attachments, etc.

General Electric Co., Schenectady, N. Y. Bulletin 42300A, illustrating and describing General Electric steam-engine-driven generating sets, which are especially manufactured for marine installations, and range in size from 2½ to 60 kilowatts. A cross-section drawing shows an assembly view of 6½- by 5-inch cylinder forced lubrication sets. Each part in the construction of these sets is described separately and fully illustrated. Reference is also made to alternating-current generating sets and their uses.

Milwaukee Electric Crane & Mfg. Co., Milwaukee, Wis. Catalogue containing 48 pages illustrating and describing the complete line of cranes made by this company. Illustrations show the different styles of cranes, and this equipment in use in different plants. One section of the book describes the Milwaukee horizontal drilling and boring machine, which is especially designed for operating at one setting on pieces that are too long and bulky to be handled on the usual type of machine. Copies may be obtained upon request.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill. Calendar for 1921, containing on each sheet, besides a calendar for three months, a list of the company's domestic and foreign sales offices, and an illustration of one of the products of this company, including pneumatic riveting hammers, air drills, electric drills, pneumatic geared hoists, pneumatic rammers, etc.

Standard Tool Co., Cleveland, Ohio. Calendar for 1921, showing illustrations of the drills, reamers, taps, milling cutters, and other tools made by the company. On the back of each sheet of the calendar is printed tabular matter, including decimal equivalent tables, metric conversion tables, weights of round, square, and hexagon steel, tap drill sizes, tap and reamer speeds, and other useful information.

Blanchard Machine Co., 64 State St., Cambridge, Mass. Catalogue containing 40 pages illustrating and describing the Blanchard No. 16 B high-power vertical surface grinder and attachments. The illustrations show the machine with the different types of drive with which it is equipped, including direct motor drive, floor motor drive, overhead motor drive, and countershaft drive. Typical examples of the work handled by this machine are also shown. The construction is made clear by the liberal use of both halftones and line engravings. This catalogue supersedes all previous editions relating to the No. 16 surface grinder.

Brown & Sharpe Mfg. Co., Providence, R. I. Booklet entitled "A Few Brown & Sharpe Graduates," containing the names of a great number of the men who have completed the Brown & Sharpe training course in the machinery trade in connection with the company's apprenticeship system. On account of difficulty of obtaining exact information as to present positions and locations of many of the graduates and apprentices, the list is but a partial one. The company would like to add as many names as possible to the next edition and would be glad to send one of the booklets to any reader of MACHINERY who is a former Brown & Sharpe graduate apprentice with a view to eliminating all omissions by the aid of men formerly trained at the Brown & Sharpe works.

Steel Products Engineering Co., Springfield, Ohio. Circular descriptive of the construction of the No. 1 universal gage grinder, giving a list of the labor-saving features and other noteworthy features of the machine, as well as complete specifications. The machine has a capacity of 4½ inches in depth and 21½ inches in length. Circular illustrating and describing in detail the 21-inch back-geared shaper formerly made by the H. J. Averbeck Shaper Co. and now manufactured by the Steel Products Engineering Co. The circular also illustrates the patented balanced driving mechanism with which this machine is equipped. Circular illustrating and describing the details of construction of the 17-inch automatic-feed regulating back-geared crank shaper formerly made by the H. J. Averbeck Shaper Co.

Cushman Chuck Co., Hartford, Conn. General catalogue for 1921 covering the Cushman line of lathe chucks. A brief account is given of the development of this business, from the time when the first Cushman chuck was made in 1862. Information relating to lathe chucks is given under the following headings: Outfits for Lathes; How to Increase the Efficiency of Lathe Chucks and Prolong their Usefulness; How Cushman Chucks are Attached to Lathes; Dimensions of Intermediate Flange Plates; and Repairs and Replacement Parts—How to Order Them. Each style of chuck is fully described, and in connection with the sizes, prices, and code words will be found carefully prepared line drawings and tables showing the dimensions of the various parts, as well as the weights when packed for shipment in various quantities. Tables are also included giving price lists of all replacement parts.

Pawling & Harnischfeger Co., Milwaukee, Wis., is distributing a publication known as the "P. & H. Chronicle," which contains a historical and descriptive sketch of the company, its personnel, size, facilities, and products. The book is illustrated with portraits of the founders of the company and the various officers, as well as with exterior and interior views of the plant. The sections devoted to P. & H. machinery and excavating machinery contain a large number of illustrations of electrical cranes, hoists, and monorail overhead conveying systems, horizontal drilling and boring machines, and various types of excavating machinery for trench and general excavation. Bulletin 5X, dealing with the P. & H. excavator crane No. 205. The pamphlet describes the many varied uses of this crane, and illustrations show the excavator at work. Details of construction and specifications are included.

TRADE NOTES

Crowell Mfg. Co., formerly at 298 Taafe Place, Brooklyn, N. Y., has moved into its new building at 319 Franklin Ave., Brooklyn.

R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland, announces that the business which it has heretofore carried on has been transferred to Trading Co. R. S. Stokvis & Zonen.

Peterson Tool & Die Works, Inc. have engaged in business as designers and makers of dies, tools, fixtures, and special machinery, at 142 Clifton Place, Brooklyn, N. Y.

Wagner Electric Mfg. Co., St. Louis, Mo., has removed its Cincinnati office to 20 E. 9th St., where it has also opened a service station. I. W. Pettingill is in charge as district manager.

Ward, Crosby & Smith, 233 Broadway, New York City, is a new firm formed by S. Mortimer Ward, Jr., Gorham Crosby, and Dyer Smith to engage in the practice of patent and trademark law.

Allison Experimental Co., Indianapolis, Ind., has changed its name to Allison Engineering Co. This is a change in name only, the ownership, management, and scope of work remaining the same as before.

Thomson Electric Welding Co. and **Thomson Spot Welder Co.**, Lynn, Mass., announce that their New York office has been removed from 1604 United States Express Bldg. to Room 3225, 120 Broadway.

Robinson, Cary & Sands Co., St. Paul, Minn., has distributed an announcement to the trade in celebration of its semi-centennial, or the completion of a half century of business dealing in machinery and railway equipment.

Welever Piston Ring Co., manufacturer of the "Wel-Ever" oil control piston rings, is now located in its new brick building at 1713 Canton St., Toledo, Ohio. The plant is equipped with new and special machinery for rapid production.

Purves Mfg. Co., Syracuse, N. Y., has moved into a factory building which has been erected for the company at Genesee and Ammon Sts. The company manufactures lubricators and oil-cups, and does a general tool and die manufacturing business.

Myers Machine Tool Corporation, Columbia, Pa., has recently completed a new two-story factory building, 52 by 220 feet, of modern construction. With the added facilities the company will be in a position to supply lathes, drilling machines, grinders, polishing machines, arbor presses, etc., in large quantities to the trade.

Reynolds Machine Co., Massillon, Ohio, manufacturer of automatic screwdriving machinery for machine screws and wood screws, announces that the company has made a substantial reduction in the price of its products, effective at once, covering the several sizes and types of automatic magazine-feed screwdriving machines.

Blodgett Engineering Co., Detroit, Mich., manufacturer of tools, die, jigs, gages, and special tools, is now located in its new plant at Roosevelt Square near the Michigan Central Railway passenger depot. The new building is a modern two-story steel and brick structure, 100 by 150 feet, equipped with up-to-date machinery.

Arrow Pump Co., Detroit, Mich., has been organized with executive and sales offices at 318 Park Bldg., 1438 Washington Blvd., Detroit, Mich., to manufacture a full line of small pumps for automobiles and machine tools, as well as for general pumping purposes. These pumps will be sold under the trade name of "Arrow."

Rivett Lathe & Grinder Co., Boston, Mass., manufacturer of precision lathes and grinding machines, announces a substantial reduction in prices of the grinding machines and lathes built by the company. These reductions amount approximately to from 25 to 40 per cent of the peak price quoted on the company's machines of different types.

Whiting Foundry Equipment Co. has changed its firm name to Whiting Corporation. The authorized capital stock of the company has been increased from $700,000 to $3,000,000. The corporation remains under the same management and will continue the manufacture of cranes, foundry equipment, and railway specialties as heretofore.

Porter-Richards Machinery Co., has been organized at 19 S. 7th St., Philadelphia, Pa., by S. G. Porter and E. I. Porter, for many years associated with the D. Nast Machinery Co. of Philadelphia, together with J. R. Richards, formerly with the Fairbanks Co. The new company will serve the trade with high-grade machine tools and accessories.

Commercial Camera Co., 10 Weybosset St., Providence, R. I., has changed its name to Photostat Corporation. The officers, personnel, business connections, and policy will continue the same as before, the purpose of the change in name being merely to more readily identify the company with its products, which include photostats, photostat paper, and photostat chemicals.

Summit Tool Co., Summit and Mulberry Sts., Toledo, Ohio, is a new concern engaged in the manufacture of jigs, fixtures, dies, tools, and special machinery. The company is located in a new brick building, 50 by 100 feet. The officers are William Coghlin, president and treasurer; Walter L. Coghlin, vice-president; James A. Kirkby, secretary; and George E. Roberts, assistant manager.

Pawling & Harnischfeger Co., Milwaukee, Wis., held a general meeting and business session of the district managers and sales engineers of the company at the Pawling & Harnischfeger plant auditorium in Milwaukee, January 25 to 27. The past year's business was discussed, and plans were made for future sales in the company's various lines—cranes, hoists, excavating machinery, and machine tools.

Calumet Truck Body Corporation, Calumet, Mich., has been organized with a capitalization of $200,000 to build what will be known as the Calumet "All-purpose" body for automobile trucks. The company desires to receive catalogues and prices from manufacturers of malleable and drop-forging parts and fittings used on truck bodies and cabs, as well as catalogues and prices of tools and shop equipment.

Northern Engineering Works, Detroit, Mich., manufacturers of cranes and hoists, have established a new office in the Pittsburg district at 990 Union Arcade Bldg. J. B. Laird, who has hitherto represented the company in western New York and northern Pennsylvania, will be in charge of the new office. Mr. Laird will cover the entire East and the Ohio valley, and will also look after the Buffalo district for the present.

Cutler-Hammer Mfg. Co., Milwaukee, Wis., has established an office at St. Louis, Mo., in the Railway Exchange Bldg., Suite 2111. This office is a branch of the Chicago district office, and its need has been felt for some time because of the increasing amount of business done in the St. Louis territory. Harold Phillips, formerly of the engineering department of Chicago and later office manager of the Chicago office, will be in charge of the new St. Louis branch.

Hoenscheid Forged Twist Drill & Tool Co., 1450 Twenty-first St., Detroit, Mich., has been incorporated with a capitalization of $50,000. The new concern will manufacture a complete line of forged twist drills, reamers, milling cutters, and special tools. The officers are P. J. Hoenscheid, Sr., president; George P. Hoenscheid, vice-president; G. W. Craighead, treasurer; and C. C. Meyers, secretary. P. J. Hoenscheid, Sr., has been the organizer of many twist drill companies and is well known as a pioneer twist drill maker.

Tock Screw Machine Products Corporation, 199-203 Eighth St., Long Island City, N. Y., announces that its business has grown so rapidly that it has been found necessary to effect a reorganization with increased capital, in order to provide more adequate facilities for the conduct of the business. The Automatic Products Corporation has therefore succeeded the former company, taking over its assets and assuming its liabilities. There will be no change in the personnel, and the business will be carried on as heretofore.

Sundh Engineering & Machine Co. announces that it is established in its new location at 1105 Frankford Ave., Philadelphia, Pa., where it is engaged in the manufacture of finishing machinery for brass mills and for makers of hot- and cold-rolled steel strip. The company is incorporated with a capitalization of $100,000. The officers are G. R. Rebmann, president; A. Sundh, vice-president; and H. F. Winters, Jr., secretary and treasurer. The sales manager is Wadsworth Doster, who was for ten years associated with the Torrington Mfg. Co., Torrington, Conn., manufacturer of brass mill machinery.

James H. Matthews & Co., 3946 Forbes Field, Pittsburg, Pa., manufacturers of marking devices and metal signs, announce that on December 24 the company gave to the workers in its organization life insurance policies, calling for increased amounts, depending upon the years of continuous service, with a maximum policy after five years. These policies were given to every worker who had been in the employ of the company one year or more, which included 64 per cent of the force. Those who received maximum policies, having been in the employ of the company over five years, constituted 21 per cent of the total number of employes.

Lumen Bearing Co., Buffalo, N. Y., announces that the company has increased its capitalization from $200,000 to $500,000, of which $100,000 is to be distributed to the present stockholders as a stock dividend of 50 per cent. The balance of the new issue is to be used to take care of the rapidly increasing business. The executives of the company are as follows: W. H. Barr, president and treasurer; C. H. Bierbaum, vice-president; N. K. B. Patch, secretary; N. F. Young, assistant treasurer; H. P. Parrock, general manager; and L. S. Jones, general sales manager. In addition to its Buffalo plant the company has also a plant in operation at Youngstown, Ohio.

Millholland Sales & Engineering Co. has been formed in Indianapolis, Ind., by W. K. Millholland and E. Millholland, who have disposed of part of their interest in the Millholland Machine Co. W. K. Millholland has been president and general manager of the latter company for the last six years, and E. Millholland has been works manager for about ten years. Temporary offices have been opened at 304 Rauh Bldg., Indianapolis, and a sales and display room will be opened about March 1. A ten-year lease has been taken on the machinery store at Capital Ave., which has been occupied in the past by Marshall & Huschart. The entire attention of the new company will be given to selling machine shop and foundry equipment and to consulting engineering work.

Detroit Machine Tool Co., 6545 St. Antoine St., Detroit, Mich., announces that it will specialize in the manufacture of ten automotive parts. The firm will also continue to make the Detroit centerless cylindrical grinder and the Detroit semi-automatic drilling machine, which have been its chief products for several years. The capitalization of the company has been increased from $150,000 to $300,000, and a larger factory has been constructed, which affords a total floor space of 37,200 square feet. The first story of the building is 120 feet wide by 220 feet long, and the second story is 120 feet wide by 90 feet long. A course in the principles of centerless grinding will be given in the grinding department, for training workmen to be expert operators on the centerless grinding machine. H. J. Swanson will be in charge of the parts manufacturing division of the company, as well as acting in the capacity of sales manager.